KNOWLEDGE
AN ILLUSTRATED MAGAZINE OF SCIENCE, LITERATURE & ART.
Founded by RICHARD A. PROCTOR.

LONDON: JULY 1, 1899.

CONTENTS.

	PAGE
Sponges and the Sponge Trade. By R. LYDEKKER. (*Illustrated*)	145
The Energy of Röntgen Rays. By Dr. J. G. MCPHERSON, F.R.S.E.	148
The Story of the Orchids.—I. By the Rev. ALEX. S. WILSON, M.A., B.SC. (*Illustrated*)	149
Microbes in Co-operation. By G. CLARKE NUTTALL, B.SC.	151
Distribution of Stars in Space. By GAVIN J. BURNS, B.SC. (*Diagrams*)	152
The Zodiacal Coins of the Emperor Jahāngīr. By E. WALTER MAUNDER, F.R.A.S. (*Plate*)	155
Galileo's Tower at Florence. By W. ALFRED PARR. (*Illustrated*)	157
Science Notes	157
British Ornithological Notes. Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.	158
Notices of Books	159
BOOKS RECEIVED	160
The Mycetozoa, and some Questions which they Suggest.—IV. By the Right Hon. Sir EDWARD FRY, D.C.L., LL.D., F.R.S., and AGNES FRY. (*Illustrated*)	161
Electricity as an Exact Science.—IV. Experience, its Value and its Danger. By HOWARD B. LITTLE	163
The Teeth on the Labella of the Blow Fly. By WALTER WESCHÉ. (*Illustrated*)	164
Microscopy. By JOHN H. COOKE, F.L.S., F.G.S.	165
Notes on Comets and Meteors. By W. F. DENNING, F.R.A.S.	166
The Face of the Sky for July. By A. FOWLER, F.R.A.S.	167
Chess Column. By C. D. LOCOCK, B.A.	167

SPONGES AND THE SPONGE TRADE.

By R. LYDEKKER.

THE ordinary conception of sponges being derived from the horny skeletons of the various kinds employed for domestic purposes, it is by no means generally realised that the graceful object known as Venus's flower-basket is the skeleton of another member of the same group; neither is it by any means a matter of common knowledge that sponges really belong to the animal kingdom. Indeed, it is not many years ago that Messrs. Cresswell Brothers and Schmitz, the great firm of sponge-importers in Red Lion Square, received an official letter in which they were addressed as sponge *manufacturers*.

Much of the ignorance connected with sponges is doubtless attributable to our acquaintance with these organisms being generally limited to the skeleton, or framework, whether this be horny, as in the case of the toilet-sponge, or flinty, as in the Venus's flower-basket. Were the sponge, as brought up fresh from the sea-bed, a familiar object, little, if any doubt would be entertained as to its animal nature.

As it comes up from the sea, an ordinary sponge is a fleshy-looking substance covered with a firm skin, in which apertures appear and disappear at intervals. If cut, the interior presents somewhat the appearance of raw meat, intersected by numerous canals and cavities. These latter are lined with a sticky, greyish-brown substance, termed "milk" by the sponge-gatherers, and sarcode by anatomists. In a sponge of simple structure, such as one of the "fingers" of the glove-sponge (Fig. 1), the water is drawn

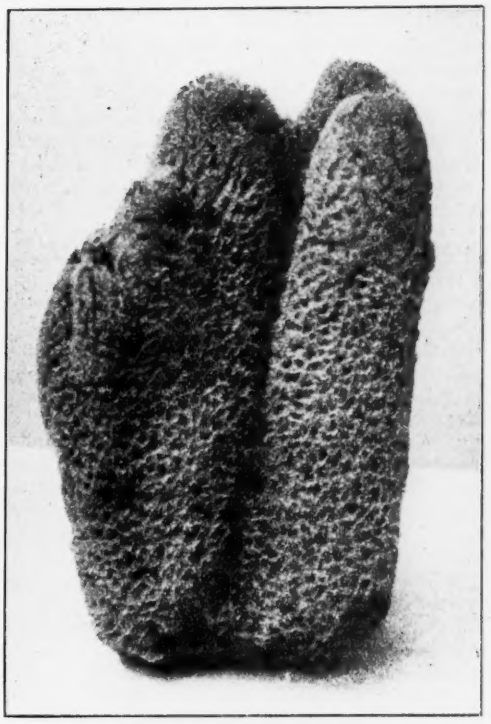


FIG. 1.—Fine Glove-Sponge. *Spongia officinalis tubulifera*. West Indies.

from the exterior through a number of pores in the surface of the sarcode, and after passing through the canals and chambers of the interior of the sponge-substance, is finally discharged by the oscula, or "waste-pipes," at the summits of the "fingers." In its course from the pores to the mouths the water passes through minute sacs, or chambers, lined with ciliated cells; and it is the currents induced by the waving of the fine hairs borne by the ciliated cells that keep up the circulation of water, and thus bring a continuous supply of food to the organism. As regards the reproduction of sponges, it will suffice to say that this is generally carried on by a true sexual process; the fertilised germs being carried out by the waste-pipes, and settling upon some neighbouring rock, pebble, or other object, where it commences to grow. Concerning the rate of growth of sponges, it may be mentioned that an ordinary bath-sponge measuring about a foot in diameter is approximately ten years old.

Commercial sponges, forming the family *Spongiidæ*, are the typical representatives of the entire group, and belong to a section in which the skeleton is composed of a horny substance, nearly related in structure to silk, and technically known as spongin. In many members of the section this spongin is hard and brittle, and it is only those kinds in which it takes the form of a soft elastic network that are of any commercial value.

The first thing to be done after a commercial sponge

is brought to the surface is to remove the sarcode, or flesh, as otherwise putrefaction speedily sets in and destroys the elastic nature of the spongin. This preliminary cleansing process is carried out at the gathering grounds, in some cases even before the vessels reach the shore. Sponges in this condition are commercially spoken of as "raw," and have to undergo a further cleansing process before they are suitable for use. How far this cleansing, or bleaching, process is carried depends on circumstances. When carried to its fullest extent, the sponge (as we may now call the cleaned skeleton) becomes of a beautiful lemon-yellow tint, and is known in the trade as "bleached"; on the other hand, when this process is carried out only to a limited degree and a more or less decided brown tint remains, the sponge is said to be "unbleached." In all cases, however, bleaching of some kind has been resorted to—a raw sponge being unusable.

The various descriptions of commercial sponges grow at all depths between two and one hundred fathoms, in seas where the temperature and other conditions are suitable. The finest descriptions and largest quantities are yielded by the Mediterranean, the chief grounds being off the Greek and Turkish islands, thence through the Dardanelles to the Sea of Marmora, and so along the coast of Asiatic Turkey and Syria to Cyprus. From there the Egyptian coasts may be followed, and thence westwards, with some local exceptions, sponges may be traced along the coasts of Tripoli and Tunisia nearly to Algeria. The Spanish, French and Italian coasts are, indeed, devoid of sponges, although they occur on the Turkish shore of the Adriatic. The very best descriptions, such as the cup-shaped toilet-sponge, are, however, met with only to the west of Malta; and as the Algerian coast is approached the sponges become gradually coarser.

Large quantities of sponges are met with off the West Indian Islands, whence the banks extend to the coasts of Florida, Mexico, and British Honduras. All these West Indian sponges, as they are collectively called in the trade, are, however, coarser, and therefore cheaper, than their Mediterranean representatives. Commercial sponges also occur in the Red Sea, the Indian Ocean, and on the Australian coasts, especially on the Great Barrier Reef. Hitherto, however, none of these have been regarded by the trade as of sufficiently good quality to repay the cost of gathering. Owing to the constant drain upon it, the sponge-fishery on the old grounds is becoming rapidly exhausted; and prices have for the last few years been advancing by leaps and bounds. The ordinary depths for fishing vary between fifteen and twenty fathoms, but of recent years sponges have been gathered off Malta at a depth of thirty fathoms. And it is hoped that the possibility of fishing at still greater depths may before long lead to the introduction of a large fresh supply of this invaluable article. By the adoption of a specially heavy diving dress, so constructed as to resist the terrible effects of pressure at such a depth, it is confidently expected that collecting in forty fathoms of water may ere long be found practicable. In the Mediterranean sponges are chiefly gathered by divers (either with or without the aid of the diving apparatus), but trawl-nets and the harpoon are also largely employed. Trawling, however, produces only damaged and inferior samples, while even harpooning does considerable harm. All Transatlantic sponges grow in shallower water, and are therefore more easily fished than the Mediterranean; and this is doubtless one, though not the sole reason, of their coarser structure. Except in British Honduras, Transatlantic sponges are collected only by means of the harpoon. An exhausted sponge-ground may be profitably reworked after an interval of four years, that period being sufficient to allow sponges that were not worth gathering at the time of cessation to grow to respectable dimensions.

Commercial sponges may be divided into two very distinct groups, the toilet-sponges (*Spongia*), and the coarser bath-sponge (*Hippospongia*). In the members of the former group the inhalent pores are situated over the whole of the outer surface; while the oscula, or waste-pipes, form much larger cylindrical apertures on the upper surface, which may be cup-shaped. Of this group two species may be recognized, namely the soft toilet-sponges (*S. officinalis*) and the hard toilet-sponges (*S. zimocca*); each of these being again divided into a number of sub-species. And here it may be mentioned that the experienced sponge dealer distinguishes many more varieties of sponges than are at present admitted by the naturalist.

The finest and most expensive of all the commercial descriptions is the fine Turkey toilet-sponge (*S. officinalis typica*), found in greatest perfection off the coasts of the Levant, where it assumes the well-known cup-like form The average wholesale price of picked specimens of this description ranges from five to nine shillings each. Next in value are the so-called "Turkey solids" (*S. officinalis adriatica*), in which the cup-shape is lost and the top of the sponge is flat. These are the only kind of Turkey found to the westward of Malta. Their wholesale price is from two shillings to half-a-crown each. In these sponges the apertures of the waste-pipes are larger than in the Turkey cups. Another remarkable variety of this species is the *lago-fitus*, or elephant's ear sponge (*S. officinalis lamella*), of the Adriatic. These form huge fungus-like lappets, which sometimes join at the edges so as to produce large open cups. Cut into small pieces they are used for house-cleaning, but the most important use of the larger sizes is for certain surgical operations; they are also employed for stuffing saddles. The wholesale price of the best descriptions varies from thirty shillings to sixty shillings per dozen.

In American waters the Turkey cup is unknown, the only cup-shaped American sponge occurring in the Gulf of Florida, and more especially at Tarpon Springs. The West Indian representative of the Turkey toilet is the glove-sponge (*S. officinalis tubulifera*) (Fig. 1), which tends to grow in a number of finger-like processes, each, when fully developed, terminating in the aperture of a large waste-pipe. The best descriptions fetch half-a-crown per pound wholesale. The fine reef-sponge of the West Indies is another variety of *S. officinalis*, which assumes neither a cup nor a finger-shape, but is generally somewhat pyramidal and pointed, with the apertures of the waste-pipes forming distinct prominences. Very characteristic of the West Indies is the grass-sponge (*S. officinalis punctata*). The ordinary form (Fig. 2) is cylindrical, with a flat upper surface; the border of that surface, like the sides, is of fine texture and perforated by the inhalent pores, but the centre is occupied by the numerous small and closely crowded apertures of the waste-pipes. The margins of these apertures are more or less prolonged into a delicate lace-like fringe; and in one sub-variety, locally known as *peludo* (hair), these prolongations take the form of delicate cups. The Florida grass-sponge is a sub-variety which assumes a cup-shape, the waste-pipes all opening within the cup.

Passing on to the hard toilet-sponges, we find these easily distinguished by their denser and less resilient texture; this being due to the greater thickness of their component fibres. In all essential features they agree, however, with the soft toilet-sponges; the sides being perforated by the pores alone, while the waste-pipes open among the pores on the upper surface. The species is typified by the

European zimocca sponge (*S. zimocca typica*), which usually assumes the form of round disks, convex below and flat above, the waste-pipes opening on this flat upper surface. In the West Indies and America the species is represented

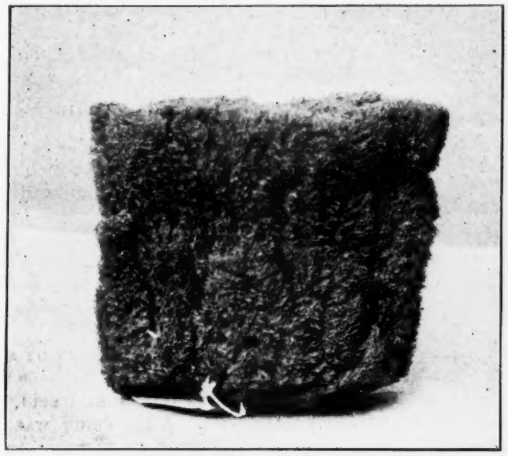


FIG. 2.—Grass-Sponge. *Spongia officinalis punctata.* West Indies.

by the hard-head and yellow sponges (*S. zimocca corlosia*). In both these the shape is more or less loaf-like, with the apertures of the waste-pipes distributed somewhat irregularly over the upper surface. In the hard-head, the general surface is fairly uniform, and the margins of the apertures of the waste-pipes are distinctly produced. On the other hand, in the yellow sponge (Fig. 3), the general surface is traversed by a number of irregular fissures, and the apertures of the waste-pipes are not produced, the whole appearance of this sponge being coral-like. None of

FIG. 3.—Yellow Sponge. *Spongia zimocca corlosia.* West Indies.

these hard toilet-sponges bear a high value; the price of good samples of the West Indian varieties ranging from about two to three shillings per pound at the wholesale dealers.

Much coarser, and of a totally different type of external structure, are the bath-sponges of the genus *Hippospongia*, which are also common to the Mediterranean and the American side of the Atlantic. Most persons, if they gave any attention at all to the subject, would probably consider that the large apertures in a bath-sponge correspond to the oscula, or apertures of the waste-pipes, in a toilet-sponge, and the smaller holes of the former to the pores of the latter. Such a supposition would, however, be totally incorrect, for, as a matter of fact, both the oscula and the pores open on the surface of the tortuous tubes leading from the large apertures into the body of the sponge. A bath-sponge, therefore, really consists of complexly-folded layers, with the system of incurrent and excurrent canals in their thin walls. To the large apertures in sponges of this type the name of pseudoscula is applied; while the twisting passages leading from them are known as vestibules. The typical bath-sponge (*Hippospongia equina typica*) is a Mediterranean species, ranging from Eritra, opposite the Island of Chios, to Tunisia, being represented by a very coarse dark brown variety at Gibraltar. It attains to very large dimensions, and its form and general appearance are too well known to require description. In the trade it is termed honeycomb sponge, and is sub-divided into bath and toilet descriptions; the two latter terms being thus used in a different sense from their scientific application. For large specimens of the best quality the wholesale price ranges from ten shillings to twelve shillings and sixpence each.

On the other side of the Atlantic the ordinary bath-sponge is replaced by a somewhat coarser variety known as the wool-sponge (*H. equina gossipina*). The essential feature of this sponge (Fig. 4) is the production of the

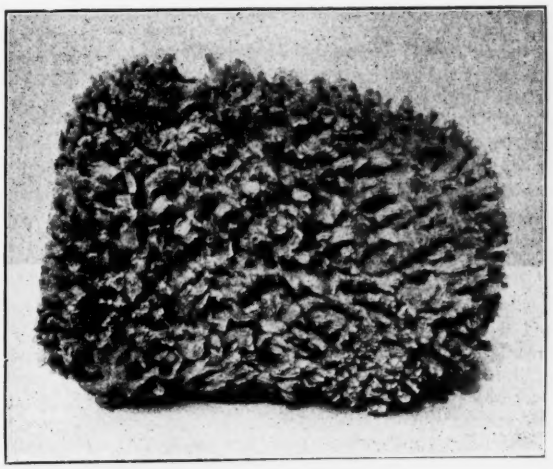


FIG. 4.—Wool-Sponge. *Hippospongia equina gossipina.* West Indies.

free edges of the laminæ into long tag-like processes, thus giving to the whole a somewhat woolly appearance. It is of inferior value to the European variety. Good samples of these sponges realise from eight shillings to eight shillings and sixpence per pound.

The last kind to be noticed is the West Indian velvet-sponge (*H. equina meandrina*), which, although here regarded as a race of the bath-sponge, is so distinct, as to have considerable claims to rank as a species by itself. Apart from the large "pseudoscula," this sponge (Fig. 5), as its Latin name denotes, presents a considerable likeness to the brain-coral. The pseudoscula are not only large, but are also very numerous. Between these the edges of the laminæ are smooth and velvety, the intervening apertures

mostly taking the form of irregular sinuous slits, although tending to become circular round the margins of the pseudoscula. Velvet-sponges are inferior in value to the wool-sponge, the best samples selling at about four shillings and sixpence each.

Before concluding this portion of the subject, a few additional lines may be devoted to the distribution of the Mediterranean sponges. On the east shore of the Adriatic,

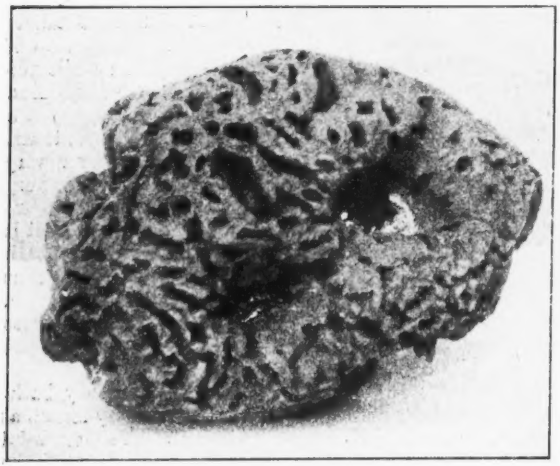


Fig. 5.—Velvet-Sponge. *Hippospongia equina meandrina.* West Indies.

and the coast of Greece from Trieste to the Bay of Nauplia, it appears that only the elephant's-ear-sponge is met with. From Nauplia and Candia to Eritra, on the coast of Asia Minor, both the Turkey toilet and the Zimocca sponge are met with. Except off Cyprus, where the latter does not grow, the Turkey toilet, the Zimocca, and the bath-sponge are met with from Eritra to Tripoli. West of the latter place the Zimocca disappears; the bath and Turkey alone extending from Tripoli to Tunisia, and the former, as already said, being represented by a coarse variety known as gerbis, in the Strait of Gibraltar. The limitation of the Turkey cups to the seas east of Malta has been already referred to.

Many years ago the head-quarters of the sponge-trade were located at Trieste; subsequently they were transferred to Paris, whence they finally migrated to London, the great bulk of the trade being in the hands of the Messrs. Cresswell.* As regards the volume of the British trade in this commodity, the following figures give the amounts and values of the imports between the years 1862 and 1870, subsequently to which no returns were published for a considerable period :—

Year.	Amount.	Estimated Value.
1862 ...	544,882 lbs. ...	£100,204
1863 ...	474,748 ,, ...	77,907
1864 ...	540,172 ,, ...	60,278
1865 ...	694,128 ,, ...	103,780
1866 ...	895,369 ,, ...	96,768
1867 ...	980,259 ,, ...	86,201
1868 ...	997,447 ,, ...	119,917
1869 ...	1,221,673 ,, ...	156,965
1870 ...	837,159 ,, ...	160,162

* To the members of this firm the author's best thanks are due for much valuable information, and likewise for the specimens from which the descriptions and figures are taken.

These figures indicate, on the whole, a progressive annual increase in the amount of the imports, with very considerable fluctuations in value. According to the Board of Trade returns, the amount of the imports in 1897 was one million nine hundred and fifteen thousand and seventy-five pounds, with a declared value of two hundred and twenty-seven thousand two hundred and forty-six pounds. The latter must, however, be regarded as only a very rough approximation to the reality. As regards the great excess in the amount of the imports over those given in the foregoing table, it must be borne in mind that during the former period the great bulk of the trade went to foreign ports. In 1875, for example, the French imports reached two hundred and forty-six thousand six hundred and sixty-six kilogrammes, and two hundred and fifty-seven thousand eight hundred and seventy-eight kilogrammes in the following year. It is accordingly quite possible (although we have no data to go on) that the total annual yield of sponge for the world's supply may now be considerably less than formerly.

As regards the dressing of raw sponges, it may be well to mention that the so-called unbleached descriptions are treated locally with a bath of weak sulphuric acid, by which they are turned light brown. After being washed in sea-water and sprinkled with sand to increase their weight, they are packed in bales, and on arrival are sold in this condition. On the other hand, the bleached sponges arrive in this country in the raw condition, stowed in bags, and pressed flat. After a good maceration in Condy's fluid, they are soaked and squeezed in a solution of sodium hypo-sulphite and hydrochloric acid, after which they are wrung, dried, sorted and trimmed. Their lighter colour gives them a decided advantage in appearance over the unbleached descriptions, but there is the drawback that the strength of the fibre is very slightly weakened by the processes to which they have been subjected.

THE ENERGY OF RÖNTGEN RAYS.

By Dr. J. G. McPherson, F.R.S.E., *Science Examiner in the University of St. Andrew's.*

Since the marvellous properties of the Röntgen rays were discovered, very many experiments have been made to bear upon their application to physiology and surgery. Dr. Polland's Atlas of the development of the formation of the bones of the wrist from birth till seventeen years of age is one of the most startling of the recent successes of the process; and this has overturned to some extent the old theory of the formation of these bones.

There has been, however, as yet but little done to determine the *energy* of these rays. The Rev. Alexander Moffat, B.Sc., has been studying the subject in Erlangen, and has submitted to the Royal Society of Edinburgh the result of his investigations.

A. Rotti was the first to attempt to determine the duration of the Röntgen rays. He used a Ruhmkorff coil with a rotating interrupter to make and break the current in the primary circuit. On the interrupter he mounted a photographic plate, and in front of it had a screen of lead with a slit in it. The Röntgen rays were made to pass through the slit and make a photograh of it on the plate. From the amount of broadening of the photograph he found that the duration of a discharge was about $\frac{1}{600}$ second.

Dr. Trouton, of Liverpool, adopted the method of rotating a zinc-toothed wheel between the Röntgen lamp and

the photographic plate. A photo of the moving teeth was secured by making one interruption of the primary current in the induction coil, thereby letting one discharge pass. The duration of the radiation was determined by the departure from sharpness of outline of the photo; and he concluded that the duration of a discharge was from $\frac{1}{800}$ to $\frac{1}{10000}$ second. M. Colandeau, adopting the same method, found the result to be about $\frac{1}{1000}$ second.

M. Morize adopted Rotti's principle. He fixed the plate to one end of the axle of an electrometer, and at the other end he placed a toothed wheel which interrupts an electric current, and makes a contact which registers itself on a chronograph band. From the broadening of the image of the slit he found the duration of the discharge to be a little over $\frac{1}{1000}$ second.

Mr. Moffat has now determined that this figure is far too low. In fact he proves that the real duration is about a tenth part of that determined by Colandeau and Morize. He used an optical bank with a screen of barium platinocyanide and the Röntgen lamp at one end; an amylacetate lamp, as a source of light, being at the other end to note the standard of comparison. Between these was a movable photometer. In order to obtain as strong Röntgen rays as possible, he introduced an air spark into the circuit, thereby driving away the particles of dust in the air and making the discharge more sudden. The Röntgen lamp and the spark interrupter were enclosed in a box, the lamp being fixed near one side. At the place where the rays from the anti-cathode were to be transmitted, a small hole was bored and covered with thin black paper. On the other side of this paper the screen was fastened. In front of the screen was fixed a piece of cardboard with a small hole in it, and through this the light-emitting surface of the screen appeared.

The light from the test lamp had to be weakened, because the light proceeding from the screen was very faint. This was done by putting the lamp inside a wooden box. A hole was made in front of the box, and covered with translucent paper. In front of this was placed a piece of green glass. For a photometer he used simply two mirrors set at right angles to one another; in this way very little of the light was lost. To determine the quantity of light emitted by the translucent paper from the amylacetate lamp, he put at one end of the optical bank a lamp, and at the other end the box with the translucent paper thus illuminated. He found that the light emitted by the paper was one-twentieth of that of the lamp.

He then removed the translucent paper, and determined the extinction co-efficient of the green glass by measuring the intensity of the light transmitted by them in comparison with that of the lamp alone. He found that the intensity of the light coming from the translucent paper, when weakened by transmission through the green glass, was about $\frac{1}{50000}$ lamp.

Now, the light of the lamp is emitted during the whole time it is burning, but the Röntgen rays only during very short intervals of time. To determine the upper limit to the duration of these intervals, Mr. Moffat put in front of the screen an opaque screen with a small vertical slit, and examined the image of the slit in a rotating mirror. The slit was three millimetres broad, and the mirror was exactly opposite it at a distance of 27·5 cm., revolving at the rate of about ten revolutions per second. Now, he saw that the image was broadened one-tenth part. Accordingly, the duration of a discharge must have been about $\frac{1}{2} \times \frac{1}{10} \times \frac{1}{10} \times \frac{3}{275} \times \frac{7}{44} = \frac{1}{1200000}$ second.

By a series of successful experiments Mr. Moffat has averaged the duration of a discharge of the Röntgen rays at $\frac{1}{1000000}$ second. This, at least, is the upper limit.

THE STORY OF THE ORCHIDS.—I.

By the Rev. ALEX. S. WILSON, M.A., B.Sc.

THE family of Orchids is represented in this country by a number of species some of which are among the most handsome of our native wild flowers. Even from a florist's point of view, the purple spikes of *Orchis mascula* and *O. latifolia* are but little inferior to garden hyacinths and greatly excel them in scientific interest. Some of the tropical kinds, which are so largely cultivated under glass, present the most fantastic shapes and are arrayed in the utmost variety of gorgeous colouring. Orchids are herbaceous plants with sheathing, strap-shaped, parallel-veined leaves; they have close affinities with the irises, daffodils and lilies. In Monocotyledons the two sets of floral envelopes are coloured alike and not readily distinguishable; we do not therefore speak of a calyx and corolla, but of an outer and inner whorl of the perianth. The gay-coloured parts of the orchid are the perianth segments; Monocotyledons with a bright-hued perianth of this description constitute the sub-class, Petaloideæ. As in the irises and daffodils, the ovary of the orchid is placed below the flower; in the two former it contains three cells; the ovary of the orchid is one-celled with the ovules attached to the internal walls. During the development of the flower the ovary twists so that those parts which are uppermost in the bud become lowest in the fully expanded blossom. The fruit is an elongated capsule which splits by longitudinal slits and discharges the minute seeds. The latter are exceedingly numerous; the contents of a single capsule have been computed in some cases to amount to as many as one million seven hundred and fifty thousand. The name orchis refers to the root, which in the early purple orchis consists of two rounded nodules or tubers. If these be examined after the plant has flowered, one of them is found to be soft, flaccid, and withered; the other hard and fresh. The starchy materials, elaborated by the leaves out of the atmospheric carbonic acid during the summer months, have accumulated in the hard tuber, and in ordinary course would be expended next spring in the production of stem, leaves, and flowers; the tuber would then have acquired the withered appearance of its neighbour, which has already been exhausted in the formation of the leaves and flowers of the present season. By that time, however, a new tuber would have formed, containing reserve materials for the following year. The tuber is thus a kind of vegetable savings-bank, in which little piles of starch granules take the place of silver and golden coins. The curious bird's-nest orchid receives its name from the rounded mass of interwoven root-fibres. The whole plant is of a dingy brown colour. Having no chlorophyll, it is incapable of assimilating the atmospheric carbon. Its mode of nutrition resembles that of the mushroom, toothwort, and other saprophytes, which obtain their food from decaying organic matter in the soil.

FIG. 1.—Spike of Early Purple Orchis.

A large proportion of orchids are epiphytes, or air-plants,

XUM

growing on trees; these often produce aerial tubers, and have long pendant roots, which do not, however, establish any connection with the soil. A few are climbers, others grow on rocks, but the majority are terrestrial like our British species, which abound in damp meadows.

The perianth of the lilies, irises, and daffodils, is regular, all the parts in each whorl being of similar size and shape; orchids, on the other hand, have a highly irregular perianth. Notwithstanding the eccentricities of their shapes, however, the flowers of orchids are comparatively simple in structure, and may be regarded as merely modifications of the ordinary liliaceous type, which is made up of five alternating whorls of five parts each. The irregularity of the perianth is mainly due to the extraordinary development of the labellum or lower lip. This organ is formed by the combination of one of the inner segments of the perianth with two sterilized stamens of the outer staminal whorl, its composite nature being usually indicated by its

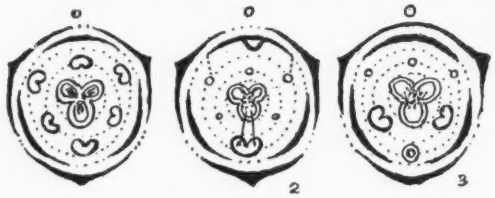


FIG. 2.—Floral Diagrams: 1, Lily; 2, Orchis; 3, Cypripedium.

three lobes. The labellum is frequently more highly coloured than the other parts; in many species it is prolonged into a hollow spur behind; in others it is tongue-shaped; while in the slipper orchid it forms a concave pouch or cup in front of the flower. At first the labellum is superior, but in many species, by the twisting of the ovary, the flower is inverted so that the labellum comes to be available as a landing-stage for visitors. Sometimes it is divided by contractions into three regions, which are distinguished as the hypochilium, next the base, the mesochilium and epichilium.

Of the six stamens, which, theoretically, the flower ought to possess, only one is fully developed, the others being represented by abortive structures termed stammodes. The single fertile stamen is adherent to the style, a condition described as gynandrous, and the combined structure constitutes the column. The pollen contained in each of the anther-lobes coheres into a waxy mass or pollinium, the stalk of which is furnished with a viscid disk at its lower extremity. The only other flowers in which pollen-masses of this description occur are the Asclepiads, an order of Dicotyledons, having no affinity whatever with the Orchidaceæ.

A characteristic structure in orchid flowers is the rostellum, which in our commoner species is a little knob projecting from the top of the column, just above the entrance to the spur of the labellum. It appears to be one of the three stigmas of the original type, metamorphosed in a remarkable manner. The rostellum consists of a membraneous pouch containing two little rounded disks of sticky matter which are attached to the bases of the two masses of pollen. When any object touches it, the membrane of the rostellum ruptures, and the sticky disks are exposed, whereby the pollen-masses are glued to the object. This can easily be verified by inserting a pencil into the flower; on withdrawing it the pollen-masses will be seen to have fastened themselves to the pencil by their sticky glands.

On the lower side of the column, immediately behind the rostellum, the two functional stigmas are situated; they are merely flat viscid areas, to which pollen readily adheres, and may be more or less confluent from the line of division becoming obliterated.

The early spring orchis, *O. mascula*, may be taken to illustrate the mode in which cross-fertilization is accomplished. Humble bees are its most frequent visitors, and the flower is specially adapted to their visits. Alighting on the labellum the insect thrusts its tongue into the hollow spur, the mouth of which is wide enough to admit of this being easily done without touching the rostellum. But the insect's head is too large to enter the spur, which is longer than the bee's proboscis; in the effort to reach the bottom of the spur the visitor pushes its head against the rostellum, with the result that the two pollen packets adhere to its forehead, and are removed when the insect withdraws from the flower. At first the pollinia stand erect, but in the course of thirty seconds or so they spontaneously curve into a horizontal position, and project in front of the bee's head. If now the insect should enter another orchid the pollina are so placed that they must inevitably be pressed against the viscid surface of the stigmas, on which one or both may be left adhering. Generally a portion only of the pollen is left on the stigma, the remainder being available for other flowers which the insect may subsequently visit. The stigmas being placed below the anther, the pollen-masses, if they retained their erect position, could not be delivered at their proper destination; instead of being transferred to the stigma they would be pressed by the insect against the anther of the second visited flower.

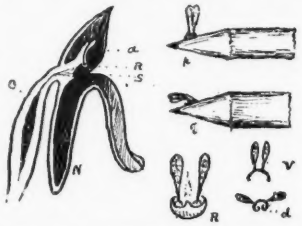


FIG. 3.—Diagrammatic Section of Orchid: *a*, anther; *r*, rostellum; *s*, stigma; *p* and *q*, pollinia; *v*, pollinia of *O. pyramidalis*, with saddle-shaped disk.

The automatic bending of the pollen-masses is thus a provision for insuring their proper delivery. It is a rather remarkable circumstance that in the genus Orchis the spur never contains any nectar; not without reason therefore have the various species of orchis been described as "sham-nectar producers," or flowers which practice deception upon their visitors. It has been shown, however, that insects pierce the succulent tissue which lines the interior of the spur, and that probably from its cells they extract a sweetened sap. A bee at work on the early purple orchid has been observed to spend three or four seconds in each flower-bell, which is long enough to allow the cement of the sticky disks to harden sufficiently; two seconds or so are spent in passing from one flower to another; and as the visitor rarely remains more than twenty seconds on one spike, it has passed to another spike before the pollinia belonging to the first have assumed the horizontal position. The cross-fertilization is thus insured not merely of separate flowers but of distinct individual plants.

The marsh orchis, *O. latifolia*, and the spotted orchis, *O. maculata*, two of the commonest species, are fertilized very much in the same way as *O. mascula*. Their spurs are slightly shorter, however, and, perhaps, for this reason the spotted orchid is frequented by flies fully more than bees. The fragrant orchid, *Gymnadenia conopsea*, has a much longer spur than any of those previously named; its flowers are visited by numerous moths and butterflies, the abundant nectar being only accessible to Lepidoptera.

MICROBES IN CO-OPERATION.

By G. CLARKE NUTTALL, B.Sc

OF late years botanists have been made very familiar with that kind of relationship shown to exist in certain instances in the plant world which is known as Symbiosis. In these instances we find two organisms living a common life of mutual benefit, each supplying the other with some requisite of its existence, and receiving in return some essential to its own well-being. The arrangement does not necessarily benefit both sides equally, and never is the advantage of the same nature on either hand; the essential point is that there is a common life of two organisms with a mutual advantage of some kind or other. A lichen is, perhaps, the best and most striking illustration of a symbiotic union, where a minute rudimentary green plant—an alga—and a fungus, living and growing in intimate connection, give rise to that product which we term a lichen thallus. In this case the mutual benefit lies in the fact that the alga provides food for the fungus, and the fungus stimulates and shelters the alga.

Metabiosis—we owe the name to the French chemist Garré—is another kind of relationship existing in certain cases which is of later recognition and not so generally known at present. For one thing, all the instances yet found of this condition are confined to the world of the bacteria, and hence do not furnish so obvious or so familiar examples as the lichens do of symbiosis; moreover, there is lacking in metabiosis that suggestion of sensationalism which caused so much interest and controversy when the double nature of the lichen household was first put forward for acceptance. Nevertheless, metabiosis, as a condition of life, has, for an interested observer, a fascination peculiarly its own.

Now, metabiosis may be broadly defined as that relationship which exists between two organisms when for one of the two to flourish and live in a certain medium it is necessary that the other should have preceded it and prepared the way for it. The development of the one with its consequent reaction on the environment is a necessary condition of the development of the other. The first is independent of the second and in no way touches it in any intimate way; the second is wholly dependent upon the good offices of the first, for without its predecessor had lived and developed and through its living changed the character of its environment it could never have been called into active life.

An example will perhaps best serve to illustrate the point. It was found some time ago that certain of the very finest wines produced in the vineyards of the Rhineland were made from grapes that, after they had been gathered, were allowed to stand and go mouldy and "bad," and apparently become absolutely useless and disagreeable. Yet it was from these very grapes that the wines possessing the best flavour resulted. Now, a clever German chemist, Müller Thergau, examined the matter from a scientific point of view, and he found that the mouldiness which appeared on the grapes after standing was a fungus which lived on the contents of the grapes, and which in absorbing its food changed the chemical constitution of those contents, so that when the fermentation processes began through the agency of yeast organisms, they were favoured and affected for the better by the changes which had already been brought about by the mould fungus. Here then the yeast stands in a metabiotic relationship to the mould fungus. The mould is absolutely independent of the yeast and appears under any circumstances, the yeast organism can only take that particular line of development with the resulting production of "bouquet" when the way has been prepared for it by the mould fungus. It is dependent upon its predecessor for its particular action—that is to say, we have here a condition of metabiosis.

Prof. Lafar gives an instance of a whole series of metabiotic relationships when he explains, with much lucidity, the sequence of events in the evolution of wine from the grape.

The skin of the grape, he says, is naturally the home of many varieties of fungi, especially bacteria, and when the grapes are gathered and pressed down these germs are naturally also to be found in the "must." And since the germs are of many varieties, they, of necessity, differ as to the conditions most favourable to their development, and as to the length of time they demand for the various stages in their life processes.

The first to develop are the yeasts—the organisms which bring about ordinary alcoholic fermentation. These seize upon the sugar of the grape for food and split it up into carbon dioxide and alcohol, and thus at once the original constitution of the "must" is greatly altered. Another species of germs, hitherto lying dormant, then spring into activity, as the conditions are now those which most favour its development. These are the organisms which bring about acetic fermentation, for their food is the alcohol which the yeast brought into existence, and they, in acting upon it, oxidise it by means of the free oxygen in the air, and thus produce acetic acid. It is obvious that the relationship between the two species is here again one of metabiosis; the bacteria producing acetic acid could not have developed in the "must" as it was in its earliest form, for no alcohol was then to be found in it; the germs might be abundantly present in the liquid, but their growth was wholly dependent on the yeast preceding them and preparing the way for them. Thus they are under an absolute obligation to the yeast, though the yeast is entirely independent of them. The result of this second stage in the proceedings is therefore a strongly acid liquid.

But now a third kind of bacteria come into play, which themselves stand in a metabiotic relationship to the second. An acid liquid is their natural home, and as the originally sweet "must" has become distinctly acidified, the dormant germs of this species are aroused into activity. They seize upon the acetic acid present, and under their influence it rapidly becomes split up into carbon dioxide and water. The bacteria accomplishing this are the thread fungi (the vinegar eel is one of the members of this variety), who thus form a third link in the metabolic chain, and their special work is the elimination of the acid.

And the thread fungi are themselves the forerunners of yet another new-comer. Certain Schitzomycetes—bacteria which promote putrefaction—had entered the "must" with the dust and air in the first instance, but had had no chance of growth until this late stage, for alcohol is poison to them and acetic acid distinctly injurious. So while the yeasts were producing alcohol and the second species was replacing it with acetic acid they were compelled to remain quiescent, and it was not until the alcohol had been removed by the bacteria promoting acetic fermentation, and the acetic acid had in its turn been reduced by the thread fungi, that the way was clear for their appearance.

The above sequence of changes thus gives us several instances of metabiotic relationship, and indeed it is probable that in most cases of fermentation and putrification we have much the same sort of thing happening; in all cases, that is, where several varieties of bacteria have their habitat in the same medium.

It is difficult to over-estimate the practical value which

XUM

a full recognition of the possibilities and limitations of metabiosis may have. At present we can scarcely claim to do more than stand on the threshold of the new study. Up to now the aim of the bacteriologist has been chiefly to isolate single kinds of bacteria, and by cultivating them in a pure state to study each species by itself, ascertaining its exact nature and its power of work; but in the future he will find this is only the preliminary to the more complicated study of combination, and he will have his most fascinating work in combining, adding, and subtracting, in endless variation, different species of bacteria in the same medium, and thus get an infinite number of independent results. Here is a simple example of a combination that has been artificially brought about.

A certain bacterium has been found to have the power of fermenting starch into glucose, and a certain yeast, it has been ascertained, can change glucose into alcohol. Now by putting together pure cultures of this particular bacterium and of this particular yeast into starch, alcohol can be obtained as a result of their joint efforts. This simple illustration of the power of combination merely points the way to others of greater import which may be arranged in the future, and, in fact, in judicious blending and combining probably lies the greatest development of bacteriology in the near future.

The ripening of the curd in cheesemaking is now shown to be the work of bacteria whose home is in the milk, and this is proved by the fact that if the milk is sterilised prior to cheesemaking no proper cheese can be produced, as the curd never ripens. But no single bacterium is responsible for the whole result, rather several species are involved, each contributing part, and part only, of the whole work, and living almost certainly in metabiotic relationships. For example, in certain investigations made by Dr. Weigmann in this matter, he found in several instances that two different forms of bacteria were present, and that a characteristic smell and taste accompanied their development; but when these two forms of bacteria were isolated and cultivated separately, neither was able alone to give the specific taste and smell, and not until the companionship was restored was the original result attained.

So, too, in buttermaking. It is bacteria again who are responsible for turning the cream sour and who bring about the changes in its constitution which give aroma and flavour to the butter. Dr. Weigmann, in his observations at Kiel, discovered that no culture of single species alone could give a good taste with stability when introduced into cream. Perfection of flavour with "keeping" properties were invariably the result of a blending together of several forms of these germs, and that if artificial souring was to be successful, a knowledge of judicious blending was absolutely necessary. This implies nothing more nor less than metabiotic relationships between the different kinds of the bacteria concerned. These instances are sufficient to indicate, at any rate, the vital importance of metabiosis in our study of the lives and works of the innumerable species of bacteria, and the great stress that must be laid on a right comprehension of this relationship in all future considerations in this direction.

DISTRIBUTION OF STARS IN SPACE.

By GAVIN J. BURNS, B.Sc.

IS the stellar universe infinite? As the power of the telescope is augmented, do we penetrate further and further into infinite space, ever encountering fresh systems of stars? Or do the stars ultimately come to an end leaving unfathomable and unknowable space beyond? These are questions which the study of sidereal astronomy forces on our attention, and which we cannot help seeking to answer however unanswerable they may be.

But although we may be unable to give a definite answer, yet we may obtain evidence as to the most probable hypothesis. A study of the distribution of stars of different magnitudes leads to results as to distribution in space of stars of different intrinsic brightness. Let us begin by supposing that stars of every grade of intrinsic brightness are scattered indifferently throughout all space. As there is no possible reason for supposing that stars of any one intrinsic brightness occupy one portion of the stellar universe rather than another, this is antecedently the most probable hypothesis of stellar distribution. Now consider the appearance which such a universe would present to an observer placed at any point in it. Let us, in the first place, confine our attention to stars of some given intrinsic brightness. Let x be the distance at which such a star appears to be of the first magnitude. Then, if 2·512 be the light ratio of two successive magnitudes, a star of equal intrinsic brightness will appear of the second magnitude at the distance $\sqrt{2\cdot512}.x = 1\cdot585\,x$; of the third magnitude at the distance $(1\cdot585)^2.x$; and of the nth magnitude at the distance $(1\cdot585)^{n-1}x$. Next, imagine a series of spheres of the radii x, $1\cdot585\ x$, $(1\cdot585)^2x$, $(1\cdot585)\ x$, $(1\cdot585)^{n-1}x$. Then the first sphere will contain all the stars of the first magnitude and over, the second sphere all the stars of the second magnitude and over, and the nth sphere all the stars of the nth magnitude and over. Since the content of a sphere is as the cube of the radius, it follows that the number of stars in each successive sphere will be as the numbers 1, $(1\cdot585)^3$, $(1\cdot585)^6$, $(1\cdot585)^9$, etc., or nearly as the series, 1, 4, 16, 64, 256, etc. In the second place, let us take the stars of some other given intrinsic brightness, and let y be distance at which such a star appears of the first magnitude. Then imagine a series of spheres of radii y, $1\cdot585y$, $(1\cdot585)^2y$,...$(1\cdot585)^{n-1}y$. As before, each successive sphere will contain all the stars which appear to be of each successive magnitude or over, and which are of the order of brightness under consideration. The number of stars in each sphere will also be as the series 1, 4, 16, 64, 256, etc. Precisely the same reasoning will hold good of stars of any other order of intrinsic brightness. The final result is that the number of stars of each magnitude and over will form a series proportional to the series 1, 4, 16, 64, 256, etc., provided only that stars of each grade of intrinsic brightness are scattered indifferently throughout space. This result is quite independent of the relative numbers of stars of each grade of brightness.

It appears, further, that if the number of stars of the first magnitude and over is represented by 1, the number of stars of the second magnitude and under the first is represented by $4 - 1 = 3$, of the third magnitude and under the second by $16 - 4 = 12$, and so on, the series being 1, 3, 12, 48, 192. Further, the number of stars between the n and $n - 1$ magnitude will always be three times the total number of stars over the $n - 1$ magnitude. Let us compare these results with observation.

The following table, showing the number of stars of each magnitude in the northern hemisphere, is given on the authority of Mr. Plummer.* The table is derived from the data in Argelander's *Durchmusterung*:—

* *Monthly Notices*, XXXVII., p. 436. The numbers in the last column have been added by myself.

Magnitude.	Number.	Ratio to total of preceding stars.
1·0 to 1 9 ...	10 ...	—
2·0 to 2·9 ...	37 ...	3·7
3 0 to 3·9 ...	130 ...	2·8
4·0 to 4·9 ...	312 ...	1·7
5·0 to 5·9 ...	1001 ...	2·0
6·0 to 6·9 ...	4386 ...	3·0
7·0 to 7·9 ...	13823 ...	2·2
8·0 to 8·9 ...	58095 ...	2·9
9·0 to 9·5 ...	237131 ...	3·5

It will be observed that there is no striking deviation from the theoretical ratio, except in the case of stars of the 9·0 to 9·5 magnitude, where the actual ratio is three and a half times the theoretical amount for a half magnitude.

For comparison with the above I have constructed, from the data contained in *Uranometria Oxoniensis*, the following table, which contains the stars in the northern hemisphere down to the sixth magnitude :—

Magnitude.	Number.	Ratio to total of preceding stars.
Over the 2nd ...	17 ...	—
2 to 2·99 ...	40 ...	2·35
3 to 3·99 ...	133 ...	2·33
4 to 4·99 ...	407 ...	2·14
5 to 5·99 ...	1265 ...	2·12

The above table shows that, so far as the sixth magnitude, the stars are really much more regularly distributed than appears from the *Durchmusterung*, and suggests that the irregularities from the sixth to the ninth magnitude are due to errors in the estimation of magnitude.

Another question that arises is whether the stars of various magnitudes are scattered indiscriminately in the sky, or whether bright and faint stars are aggregated in definite localities. In order to test this point, I have made an enumeration of all the stars in the *Durchmusterung* lying between 1° N. and 1° S. declination, with the following result :—

Magnitude.	Number.	Ratio to total of preceding stars.
1·0 to 1·9 ...	*Nil.*	
2·0 to 2·9 ...	2	
3·0 to 3·9 ...	5 ...	2·5
4·0 to 4·9 ...	10 ...	1·4
5·0 to 5·9 ...	21 ...	1·2
6·0 to 6·9 ...	71 ...	1·9
7·0 to 7·9 ...	283 ...	2·6
8·0 to 8·9 ...	1789 ...	4·6
9·0 to 9·5 ...	7526 ...	3·5

It will be seen that, while the actual proportion of the stars of each magnitude varies considerably from that in the whole hemisphere, there is a similar marked increase in the number of stars below the 8th magnitude.

The accompanying diagram (Fig. 1) represents an ideal section through the stellar universe, showing how stars of equal intrinsic brightness would have to be distributed in order to appear as they are shown in the above table. When we look through a telescope, the stars included in the field of view actually lie in a cone, having the eye at the apex, and the volume of the cone is as the cube of the distance to which the telescope penetrates. Now, in this diagram, the stars within the cone are plotted on a plane sector, the area of which is as the square of the distance from the centre. The distance of a star has been assumed to be inversely as the square root of the apparent brightness. Hence, in order that the distribution, as shown on the plane surface, may truly represent to the eye the assumed distribution in space, the number of stars of

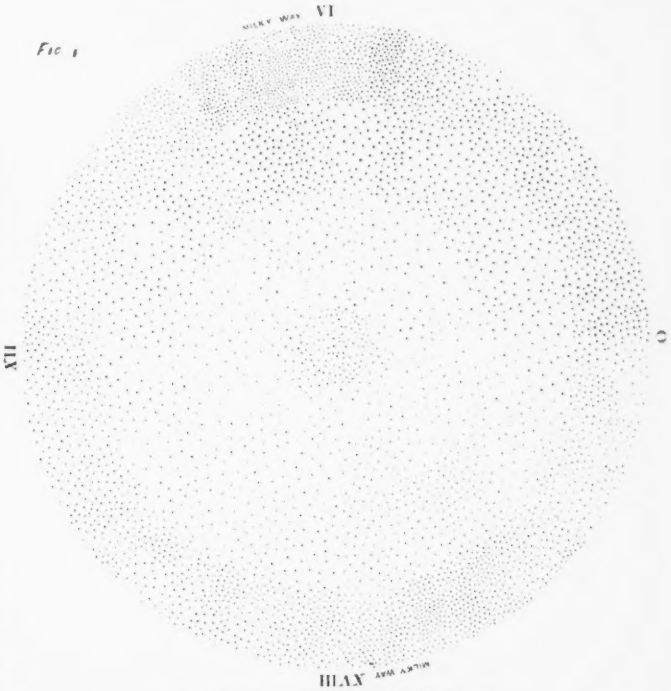


FIG. 1.

Section through the Stellar Universe.

each magnitude has been multiplied by a co-efficient. Further, the stars here dealt with, viz., those within one degree of the equator, were divided into groups, each occupying thirty minutes of right ascension, and each group plotted in its proper sector. The following table, showing the calculation for one group, will explain the process :—

Magnitude	2·0 to 2·9	3·0 to 3·9	4·0 to 4·9	5·0 to 5·9	6·0 to 6·9	7·0 to 7·9	8·0 to 8·9	9·0 to 9·5
No. of Stars ...	0	0	0	0	1	8	25	143
Multipliers	10	6·31	3·99	2·51	1·58	1	·63	·45
Relative density projected on a plane	0	0	0	0	1·5	8	16	64

A similar calculation was gone through for each thirty minutes of R.A., except that stars under the sixth magnitude were taken together, on account of their small number. The numbers in the last line are those shown on the diagram.

A glance at the figure shows the general character of stellar distribution in the plane of the equator. The distribution is approximately uniform towards the centre, with a marked increase of density towards the circumference, which becomes emphasised where the equinoctial plane crosses the Milky Way.

The increased number of stars below the eighth magnitude is very remarkable if it is fact; but this depends entirely on Argelander's magnitudes being photometrically correct. There is, in fact, reason to believe that the magnitudes of the fainter stars are over-rated. An examination of the first six hours of zone — 0° showed that

XUM

out of one thousand one hundred and seventy-seven stars three hundred and eighty-five were rated at 9·5 magnitude. Now, it is very unlikely that a third of a thousand stars taken at random should be within a tenth of a magnitude of 9·5. It certainly looks as if all stars observed fainter than 9·4 were indiscriminately put down as 9·5. In order to put the question of the supposed rapid increase of faint stars to a practical test, I took six gaugings in zone − 0°, R.A. 5h. 30m. to 6h., with apertures of two and a-quarter inches and three and three-quarter inches, with the following result :—

Stars visible with aperture of $2\frac{1}{4}$ inches ... 64
Additional do. do. $3\frac{3}{4}$ do. ... 57

According to the *Durchmusterung* there are in the same region :—

Stars of 8·9 magnitude and over 25
Do. of 9·0 to 9·5 magnitude 126

The increase of aperture from two and a-quarter inches to three and three-quarter inches represents about one magnitude, so that, if the magnitudes in the *Durchmusterung* were correctly estimated, we should have expected to see about ten times as many with the larger aperture instead of barely double the number.

With a view to throwing some fresh light on the question of the increase in the number of faint stars, I determined to make a series of gaugings in the following manner : A three and three-quarter inch refractor was provided with a series of five diaphragms of diameters ·75, 1·50, 2·25, 3·00, and 3·75 inches respectively. The diameter of the field was approximately sixty-four minutes, and each set of observations consisted in counting the number of stars visible with each successive aperture. One advantage of this method is that there is a direct relationship between the aperture and the space-penetrating power, which is simply proportional to it. Another is that, as each set of observations is made consecutively with the same instrument on the same evening, the result is free from errors due to changes in the atmosphere or the use of different instruments. Although the photometric magnitude of a star will be different under different conditions for the same aperture, yet the difference of magnitude for two different apertures remains constant.

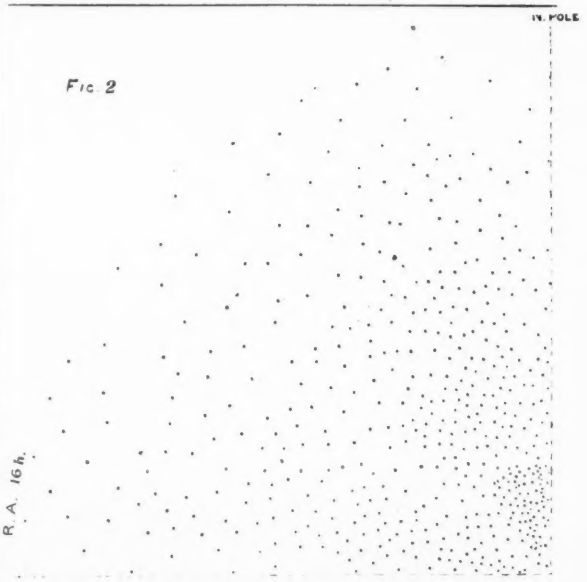
As has been already remarked, the stars seen in a telescope are contained in a cone whose vertical angle is the angular diameter of the field. If we assume that all stars are of equal intrinsic brightness, the height of the cone is proportional to the aperture, and its volume to the cube of the aperture. The following table shows the relationship of the various apertures we are dealing with and the volume of the space penetrated :—

Aperture.	·75	1·75	2·25	3	3·25
Space-penetrating power ...	1	2	3	4	5
Volume of space penetrated ...	1	8	27	64	125
Increase for each aperture ...	1	7	19	37	61
Ratio of increase to volume for next lower aperture ...	—	7	$\frac{19}{8}$	$\frac{37}{27}$	$\frac{61}{64}$
Or (approximately)	—	7	2·4	1·4	1·0

On the hypothesis of the equal distribution of stars in space, the third line gives the relative number of stars that ought to be visible with each aperture, and the last line gives the ratio of the additional stars seen with the larger aperture to those already in the field with lower aperture.

The following table gives the actual result of one hundred gaugings made in the manner above described :—

Aperture in Inches.	·75	1·5	2·25	3	3·25
Total number of stars visible with each aperture ...	118	466	923	1482	1824
Additional number for each aperture	—	348	457	559	342
Ratio of additional number to previous total	—	2·9	·98	·60	·23
Ratio on hypothesis of equal distribution	—	7	2·4	1·4	1·0



Stars of equal intrinsic brightness as actually seen.

Ninety of the gaugings above tabulated were taken on the sixteenth meridian between the pole and the equator, one to each degree. The results of these ninety gaugings are shown in Fig. 2, which has been constructed on the same principle as Fig. 1. The observations for each five degrees of the quadrant were added up, and the total, multiplied by a co-efficient, was plotted on the corresponding compartment in the diagram. These co-efficients, as has been explained, are required in order that the density may be truly represented on a plane ; they are 1, $\frac{3}{7}$, $\frac{5}{19}$, $\frac{7}{37}$, and $\frac{9}{61}$ for the successive apertures. Fig. 2 consequently represents an ideal section through the stellar universe at R.A. 16h., showing how stars of equal intrinsic brightness would have to be distributed in order to appear to an observer on the earth as actually seen.

A comparison of these two figures will show at a glance that they indicate two totally distinct systems of stellar distribution. In the one case there is a continuous thinning out of stars as we proceed outwards, while in the other case there is a decided increase in density of the stars in the more remote parts of space.

That faint stars are really much less numerous than they would be on the hypothesis of equal distribution in space, may be shown by comparing the actual number observed with the number calculated from the numbers of superior magnitudes, on the assumption that number and magnitude continue to be related by the same law. The following statement shows the result of such a comparison :

Number of stars of the 17th magnitude that ought to be seen within a circle of 1 degree in diameter if the relationship of number and magnitude, indicated by the *Durchmusterung*, continued to the 17th magnitude. } 180,000

Number of stars of the 17th magnitude that ought to be seen within a circle of 1 degree of diameter according to the relationship indicated by the *Uranometria Oxoniensis*.	33,000
Ditto ditto ditto by my own observations.	5,000
Actual number counted in a circle of 1 degree in the photograph published in the February number of KNOWLEDGE.	1,128

Upon the whole I think it very probable that faint stars are actually less numerous than they should be on the hypothesis of equal distribution in space, and that the apparent increase of density shown by the *Durchmusterung* is really due to the magnitudes of faint stars being over-estimated.

THE ZODIACAL COINS OF THE EMPEROR JAHĀNGĪR.

By E. WALTER MAUNDER, F.R.A.S.

THAT acute critic in Wonderland, Alice, remarked "What is the use of a book without pictures or conversations"; and we are afraid that to the ordinary lay mind unversed in numismatics, the great majority of Muhammadan coins must lie under the same ban. For, in accordance with the exhortation of the Qur'ān (Sūra, v. 92), "O ye who believe! verily wine and al maisar and statues and divining are only an abomination of Satan's work; avoid them that haply ye may prosper," as a rule such coins bear only inscriptions, but no device.

There are, however, some exceptions, and these of much more than ordinary interest, to which our attention was called during our stay in India some sixteen months ago.

It was our great good fortune, when passing through the city of Ahmadābād, that most interesting capital of the ancient kingdom of Gujarāt, to be introduced to Dr. George P. Taylor, M.A., who not only constituted himself our guide to all the chief buildings of the city, but who treated us to a sight of his collection of silver rupees, the most complete in the world after those of the public museums of Calcutta and Lahore. Hardly a year is wanting in the succession of coins that recall the history of the great Moghul Empire from the accession of Akbar the Great, whilst the reigns of the Sultans of Gujarāt, stretching backwards some two centuries earlier, are well represented. It was the rule of these sultans that impressed upon Ahmadābād its striking and characteristic architecture—Muhammadan ideas being carried out in Hindū workmanship.

Amongst these our attention was at once caught by several coins, which not only appeared beautiful even to our unpractised eyes, but which were evidently also astronomical. These were some of the zodiacal rupees of the Emperor Jahāngīr, son of Akbar the Great.

The story of how these coins, which seem so distinct an infraction of the Muhammadan rule which forbids the making of "any graven image, or any likeness of anything that is in heaven above, or that is in the earth beneath, or that is in the water under the earth," came to be struck is a very interesting one. Neither Akbar nor his son and successor Jahāngīr were at all bigoted Muhammadans. The former, indeed, was a decided eclectic, and, in accordance with his exceedingly broad views, had married a representative of each of the three great faiths with which he was acquainted—the Christian, Muhammadan, and the Hindū. Jahāngīr, or Prince Selim, as he was called before his succession, was the son of the Muhammadan wife, but with the influence of his father's example before him it was not perhaps surprising that he held his mother's creed but laxly.

A far more potent influence came into his life when a Persian, named Kwāja Ghyās-ud-Dīn, accompanied by his beautiful wife, and yet more beautiful daughter, visited his father's court. With the latter, Mehr-un-Nissa by name, he fell desperately in love. The emperor, in order to prevent the *mésalliance*, hurried the beautiful Persian into marriage with a valiant Turk of the name of Shere Afgan, whom he appointed as Deputy-Governor of Burdwan. Shere Afgan did not long survive his royal master, owing to circumstances upon which the new emperor, Jahāngīr, has not thought fit to enlarge in his *Memoirs*. It was not, however, until six years later that Mehr-un-Nissa was married to the emperor, under the title of Nūr Mahal ("Light of the Palace"), changed two years later into the title by which she is best known, Nūr Jahān ("Light of the World").

The extraordinary influence which this great queen exercised is a well-known fact of history, and is illustrated by coins both in silver and in gold, which bear her name along with that of her husband. Dr. George Taylor, who has kindly allowed me to quote freely from a paper of his, writes concerning these coins:—"As in the history of the Mughal Emperors of India she alone of all the Queens-Consort wielded practically supreme power, so of all the Queens-Consort her name alone is found on any purely Indian coin. On the coins of a much earlier date the name of Sultānā Ridīya does indeed occur, but she was for three years a Queen Regnant (A.D. 1236-1239). The rupees of Nūr Jahān are still occasionally to be found in the bazārs of Gujarāt. My collection contains twelve, of which nine were struck at Sūrat, between the Hijrī years 1033 and 1036, one at Lāhor in 1034, and two at Ahmadābād—a very rare issue—in 1036 and 1037. Other mints of this coin are Agrah and Patna. The legend, covering both the obverse and the reverse, runs:—

"By the order of Jahāngir Shāh, gold has gained a hundred splendours through the name of Nur Jahān Pādshāh Begam."

"The jeweller Tavernier, whose travels took him into Persia and India about the year A.D. 1670, records at length how the famous zodiacal muhrs and rupees came to be struck during the four-and-twenty hours that Jahāngīr permitted his wife to reign in his stead. On these coins, instead of the name of the month of issue, was stamped the figure of the sign of the zodiac corresponding to the particular month.

"The story, as recounted by Tavernier, runs thus:—

"One day that the king was extremely well pleased, and having drunk briskly began to be merry, after the queen had danced in his presence, he took her and sat her by him, protesting to her that he loved her above all the princesses in his court. . . . The queen seeing the king so highly affected towards her, failed not to make use of so favourable an opportunity. 'To which purpose, sir,' said she, 'if it be true that your majesty has that kindness for me of which you would persuade me to assure myself, I know you will grant me one favour which I have passionately desired a long time; that I may only reign as sovereign the space of twenty-four hours.' This request surprised the king, and kept him sad for some days, being unwilling to deny her anything, and yet being as loath to grant her a boon of so high a nature. In the meantime the queen plied the king with pastime and divertisements, pretending to take no notice of his melancholy. At length, the fifth day after she had made her petition, the king, no longer able to resist her charms, nor the strong passion he had for her, told her he would retire for twenty-four hours, and that she might assume the absolute command of the kingdom during that time. . . . It was a long time before that the queen had made everything ready, and that she had secretly hoarded up great quantities of gold and silver in all the cities where the mints were appointed, and had distributed the stamps as she thought convenient. And indeed it was a wonderful thing that a woman should so politically carry on so great a design as to have four-and-twenty stamps engraved, and to

keep in readiness in gold and silver about two millions in all the cities, without being discovered to the king or any of the court. . . . The day being appointed, she sent away messengers to all the cities, commanding them on that date to coin rupees of gold and silver to the value already mentioned. . . . The thing was so suddenly done, especially in the cities near at hand, that within two hours after she was sate upon the throne, she caused several quantities of that gold and silver to be thrown among the people, which during the reign of Jahāngīr went currently for rupees. But when Sultān Kharram, who took upon him the name of Shāh Jahān, came to the throne after the death of his father, he forbade all persons to use those rupees upon pain of death, and commanded all that had any of them, either in gold or silver, to carry them to the mint, where they should receive the value of them, to the end they might be melted down. For which reason they are at present very rare, particularly those in gold. Among the rest, two or three of them are so hard to be found that an hundred crowns has been given for one of them. The rupees of gold are worth one-and-twenty livres of our money, and those of silver thirty sous. The queen, during her reign of twenty-four hours, had that respect for the king that, on the back-side of the pieces, whereon the twelve signs were engraven, she caused the name of Jahāngīr to be stamped with her own, and the name of the place where they were coined, all in Arabic letters."*

"One is tempted to regret the necessity to relegate this artless story to the domain of fiction. But its refutation comes from the coins themselves, for the dates they bear cover no less a period than nine years, the Higrī years from 1026 to 1034. Still, that there is a substratum of truth in the legend may perhaps be granted from the fact that at least three of the zodiacal coins do present the name of Nūr Jahān. These are: (*a*) A gold Sagittarius of 1035, now at Paris; (*b*) a gold Cancer of 1034, mint Ajmīr, once in the possession of the late Hon. Mr. James Gibbs; (*c*) A silver Leo of 1028, described a century ago by M. Anguetil du Perron.†

"The many evident errors in Tavernier's narrative notwithstanding, I confess I should be surprised if 'my lady magnificent,' who at this time so distinctly held the *rôle* of 'predominant partner' in matters imperial, should prove to have been entirely innocent of connection with these zodiacal coins, forming, as they do, a series quite the most beautiful of all issued in Jahāngīr's reign. That he himself claims them as 'my own innovation,'‡ scarcely determines the question, for, as Talboys Wheeler says, 'Jahāngīr always exaggerated; he never told the truth in anything.'§

The emperor's own account is given in the *Waqi'at-i-Jahangīrī*:—

"'Formerly it was customary to strike my name on one side of the coin, and that of the place and the month and the year of the reign on the reverse'—this, we have already seen, had been the custom during the seven preceding years, that is, from 1020 to 1027 H.—'It now occurred to my mind,' Jahāngīr adds, 'that instead of the name of the month the figure of the sign of the Zodiac corresponding to the particular month should be stamped. . . . . This was my own innovation. It had never been done before.'"—Dowson's "Elliot," VI., 357.

"Of the zodiacal coins it would seem that 'with one or two exceptions the gold muhrs were all struck at Agra and the silver rupees at Ahmadābād.' This at least was the conclusion arrived at by the late Honourable Mr. James Gibbs, C.S.I., and communicated to the Bombay Branch of the Royal Asiatic Society in a paper read by him as President in the year 1878. (Jo. B.B.R.A.S., No. 36, Vol. XIV.)

"Of all these zodiacal coins, the reverses, struck from dies probably engraven by a European artist, and one of no mean order, exhibit on a background of solar rays some one of the conventional signs of the zodiac, while in a few cases (Cancer, Leo) even the stars of the constellations are represented. Beneath the sign comes the regnal year 13 and the phrase 'Sanah Julūs,' or, in the case of Gemini, Cancer and Scorpio, the word 'Sanah' alone.

"Of the complete series of the twelve zodiacal Ahmadābād rupees it will be seen that four (Virgo, Libra, Sagittarius, and Aquarius) are quite unrepresented in the published catalogues. That all the twelve were issued there is no room to doubt, and James Forbes, writing his 'Oriental Memoirs' in 1813, expressly states: 'I once saw an entire collection of these rupees in silver, and a few others procured by chance of the same metal.' (2nd Ed. II., 215.) While poor imitations of the whole series are still sometimes exposed for sale (in Bombay I have been offered the twelve for Rs. 25), it is much to be feared that the complete sets formerly met with, as Forbes quaintly puts it, 'in the cabinets of the curious,' have long since been broken up and dispersed."

It will be observed that in the preceding paragraph Dr. Taylor is confining himself entirely to the question of the silver rupees minted at Ahmadābād. As the plate (which, by the kind permission of the Keeper of the Department of Coins and Medals at the British Museum, we are enabled to give) shows, the British Museum collection of coins contains representatives of every one of the signs for the gold mohurs, minted at Agrah, and several forms for some of them. The plate contains nineteen of the mohurs, the twentieth giving an example of the inscription on the reverse. Of the eight signs known to exist of the Ahmadābād rupees, the British Museum collection contains all but Pisces, the last coin in the plate being a reproduction of the reverse of one of the silver rupees. I am indebted to Mr. E. J. Rapson, M.A., to whom I would here desire to express my great obligation, for the casts from which the photograph was taken.

In a large number of cases the design is evidently European. Numbers 1 and 21 show us the typical ram of Aries with the reverted head, significant, no doubt, of the position of Aries as the last and not the first of the signs of the zodiac at the time when they were originally mapped out. Number 22—the Taurus rupee—gives us again the traditional figure, the half bull charging from out of the cloud, which we still have in our atlases. Numbers 2 and 3 are, however, more strictly Indian in design, showing the humped Indian Bull in full figure; and the two examples face different ways, showing that the artist attached no significance to the direction in which the sign was turned, and that strict astronomical accuracy was not sought by him. Numbers 4 and 23—the Twins—follow the Indian and not the European zodiacs, in representing a man and woman, and not the Dioskouroi. This form—the man and woman—is common to nearly all the Oriental zodiacs, but we have seen its place taken on a Burmese zodiac by a single female figure. The Crab, Numbers 5 and 24, is a very spirited figure, and stands in high and sharp relief. The Lion, Numbers 6, 7, and 25, is one of the poorest designs, and can scarcely have been due to the same artist who designed Numbers 5, 14, and 22. It will be seen that the Lions in Numbers 6 and 7, like the Bulls, face different ways. Three forms for the Virgin follow: Numbers 8 and 9 are, without doubt, of Indian design; Number 10 recalls the conventional one known in Europe. The Scorpion is shown under several forms,

* "The Six Voyages of John Baptista Tavernier," made English by J.P., 1678 Edition, page 11.

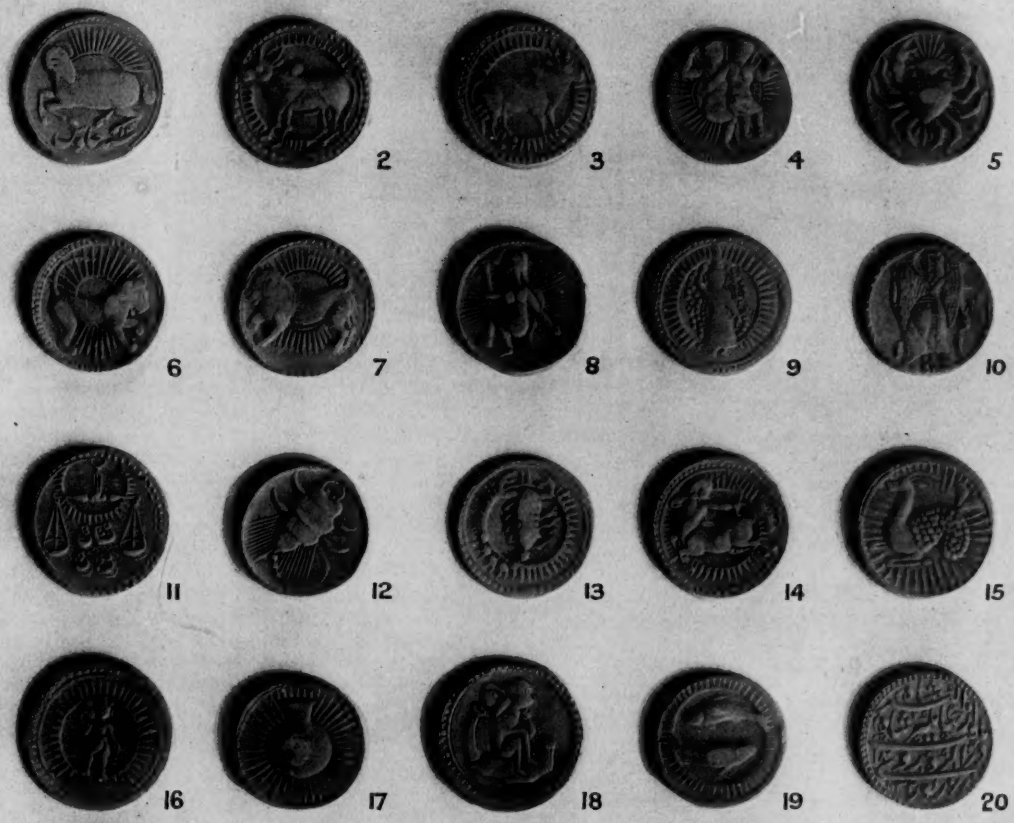
† "Notes on the Zodiacal Rupees," by the Hon. J. Gibbs, in *Journal of the Bombay Branch of the R.A. Society*, Vol. XIV., No. 36 pages 157, 160, and B. M. Catal. Mughal Emperors, page LXXXI., Note *.

‡ Dowson's "Elliot," VI., 357.

§ Talboys Wheeler: "History of India," Vol. IV., Part I., page 203, Note 20.

XUM

GOLD MOHURS MINTED AT AGRAH.



SILVER RUPEES MINTED AT AHMADABAD.

ZODIACAL COINAGE OF THE EMPEROR JAHĀNGĪR.

XUM

Numbers 12 and 18 being probably Indian, whilst the sun is omitted from the background of Number 26, possibly a reminiscence of the evil astrological repute of this "dark" and "ill-starred" sign. The Sagittarius of Number 14 is, perhaps, the finest design of the series, but the Archer is represented as firing a Parthian shot, and not, as in our zodiac, shooting before him. Capricornus, Numbers 15 and 27, would appear to have the head of a gazelle rather than of a goat. The fish-tail is very strongly emphasized in both cases. The three designs for Aquarius are evidently native, Number 17 being simply an ordinary *lotah*.

Whether we owe to Jahāngīr or to his far more gifted empress the original idea of employing the zodiacal symbols as designs for coins, it must be admitted that they have proved themselves admirably suited for the purpose. There are few indeed in the long array of stiff and formal British coins with anything like the grace and beauty of the best of these Moghul mintages.

GALILEO'S TOWER AT FLORENCE.

By W. ALFRED PARR.

FEW astronomers passing through Florence will fail to pay a visit to the picturesque old tower known as the "Torre del Gallo." This interesting old building, situated on one of the hills to the south of the city, close to the present Arcetri Observatory, is supposed to have served at one time as an observatory to Galileo. Whether this be so or not, and it has been sometimes doubted whether the founder of telescopic astronomy ever actually utilized the tower as his observatory, the building and its vicinity possess so many reminiscences of the great man that the astronomical visitor cannot fail to have his interest aroused.

One of the rooms of the tower has been fitted up as a museum, and contains an interesting collection of engravings, documents and other relics relating to the life of Galileo. A photograph of the well-known painting which

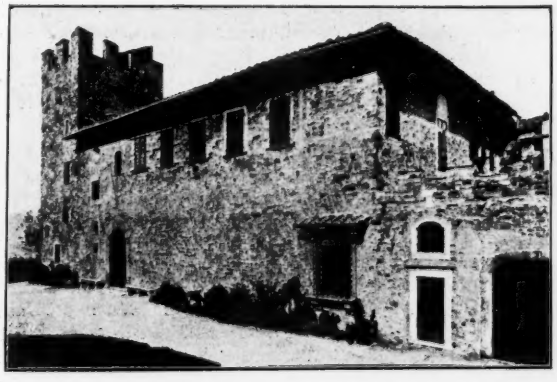


FIG. 1.—The Torre del Gallo, Florence; supposed to have been used as an Observatory by Galileo. (Photo by Brogi, Florence.)

represents Galileo before the Judges of the Inquisition is of special interest. The great astronomer stands before the assembled dignitaries of the Church, and has just pronounced his celebrated recantation of his theory of the earth's motion, when averting his head he mutters: "E pur si muove."*

Some old instruments, dating from the time of Galileo, are also exhibited here, but a far finer collection of old telescopes, some of which were in the actual possession of Galileo, is preserved in Florence at the Museum of Physical Science. Nowadays every tyro in astronomy possesses a telescope superior to Galileo's "optic glass," and it is only when contemplating these primitive old

FIG. 2.—Museum in the Torre del Gallo. The wooden staircase leads to the platform on the top of the Tower, from which Galileo is said to have made his observations. (Photo by Brogi, Florence.)

instruments that one fully realizes the greatness of the man who, with such meagre optical means, was yet able to achieve such far-reaching results.

From the top of the tower a most magnificent panorama unfolds itself, the view extending from the wooded heights of Vallombrosa on the east to the distant Carrara mountains on the west, while below, in the valley of the Arno, lies Florence.

Not far from the Torre del Gallo is situated the Villa of Galileo, where the great Florentine passed the closing years of his life, latterly deprived of sight but surrounded by a few faithful friends. It is here that he was visited by Milton in the year 1638, and here he died in 1642.

Science Notes.

Refrigeration is one of the most recent, and at the same time one of the most important applications of mechanical engineering on board ship. It is not yet twenty years since the frozen meat trade was begun between Australia and England. At the outset comparatively small cargoes were carried, but as machines were improved and experience was enlarged so larger cargoes were carried, and a new branch of the shipping industry was created. The first refrigerators were designed to deal with one hundred and fifty tons of meat. Now machines are constructed capable of dealing with three thousand tons, while they occupy only two and a half times the space and consume about three times the coal required for the first machines. Sir William White has recently pointed out that in 1881 about fourteen thousand carcases were brought to this country from the Colonies; in 1899 he anticipates that from eighteen to nineteen millions will be delivered from the Colonies and various parts of the world. In addition to meat, large quantities of butter, fruit and other perishable cargoes are now carried from the far ends of the earth and delivered in good condition.

Mr. R. A. Emerson has communicated to the Academy of Sciences, Nebraska, some interesting observations

* "But it *does* move."

made by him, over a period of four years, on the temperature inside tree trunks. When the trunks and limbs of trees are shaded, their temperatures, if above that at which water freezes, vary according to the temperature of the outside air. Moreover, in the shade, tree temperatures above the freezing point of water are higher than the air temperature when both are falling and lower when both are rising. When exposed to bright sunlight, however, the tree temperatures, in circumstances otherwise similar, are higher than the air temperature, not only when both temperatures are falling, but are often higher also when both are rising. One side of even a small limb may consequently have a temperature much higher than the air and the opposite side a temperature lower than the air.

A recent meeting of the Linnean Society was very full of interest. Mr. Botting Hemsley, F.R.S., exhibited plants from high altitudes, collected by several well-known explorers. Mr. Valentin sent photographs and lantern slides of an elephant seal eighteen feet in length, which he recently examined alive on the shore on the Falkland Islands. It was a male, the trunk being only possessed by this sex. The latter was inflated till it was a foot in length from the tip to the gape. Mr. Harting had living specimens of the rarer British vole from Skomer Island, off the coast of Pembroke. The young are brown, the adults reddish, and the hair grows remarkably fast. The President, Dr. Günther, produced a letter bearing upon the case of the gigantic land tortoises of the Seychelles, sent by the Administrator there to Mr. Chamberlain, and exhibited photographs of several specimens. The letter arose out of Dr. Günther's presidential address of last year, which treated of these reptiles and their chances of soon becoming extinct. Afterwards Sir John Lubbock read a paper on some wingless insects of Australia, and, finally, an account was given of a unique specimen of a crustacean found in a whale.

It is now over twenty years since Raoul Pictet, of Geneva, announced the results of experiments carried on with the object of liquefying that most refractory of all the so-called permanent gases—*hydrogen*, but up to a week or two ago all efforts in this direction were, at the best, problematical and unconvincing. Now, however, a grand achievement has been effected by Prof. Dewar and his able assistant, Mr. Robert Lennox. These investigators, by the undoubted liquefaction of hydrogen, have put the finishing stroke on the line of research initiated by Faraday when he first reduced the gas chlorine to a liquid. The new agent of scientific research—liquid hydrogen—congeals the air surrounding the containing tube into a snow-like solid, and a piece of cork sinks to the bottom when put in the liquid; the temperature at the boiling point is 21° absolute, or −252°, a temperature representing a pressure which is immeasurable. The liquefaction of hydrogen is a triumph of theory as well as practice, for in face of all the enormous difficulties which have been encountered, theorists have never deviated one jot from the conviction, which sound reasoning long ago showed, that there is no such thing as a permanent gas.

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

"NIGHTINGALE THRUSHES."—Between Eltham and Sidcup, Kent, are several thickets in which the Thrush abounds, and in which the Nightingale is very common in its season. The effect of this close association of the species is apparent in the song of some of the Thrushes there. In January and February a wonderfully good rendering of some typical strain of the Nightingale is often heard from a Thrush. A friend remarked upon this, he having felt assured that he was listening to a Nightingale (in March) until the bird was revealed close at hand as a Thrush. The Thrushes never attain to a good rendering of the long-drawn sweet note of the Nightingale, but they try to do it, and give a long "straight" whistle, like "pee pee pee," in the effort. Some of the other strains, however, are more successful. I have heard the "pee pee pee bobloblole" and the full bubbling note (like that of the Lesser Whitethroat) given with exactly the emphasis and accent of a Nightingale, by a February Thrush. Then the alarm, "whit-urrrr," of the Warbler has been given with exactness two months before the arrival of the bird. Many of the phrases of the Thrushes at the spot indicated also include a very rapid repetition of two notes many times, one note being a few tones higher than the other. This is a feature no doubt derived from the Nightingale, whose song so often contains a similar variation. Near Charlton Kings, in Gloucestershire, late in March, I heard a Thrush give a true strain of the Nightingale, and asked if the latter bird had not been found there last year. The answer was that a Nightingale had been heard close to the spot. My observations lead me to conclude that the best singers of Thrushes and Robins (at least) are found not rarely year after year in the same spots. I never heard the Eltham Blackbirds try to imitate the Nightingale, but one of them, this year, was certainly uttering a song consisting sometimes of nothing but one note repeated, and that note was also the note of some young Ducks! The Ducks had been there for a couple of months or more, and were noisy as usual—with the result that the poor Blackbird found himself unable to originate any better song than a kind of musical "work work work." He would give five or six phrases of nothing but this note, then add a few whistled sounds. This incident was chiefly noticeable at dawn; and it was plain that the Blackbird was very desirous to utter a nobler song, for after a time he wholly abandoned the primitive strain, and sang only the usual, varied, full songs of his species.—CHARLES A. WITCHELL.

SPRING IMMIGRATION OF THE GOLDEN-CRESTED WREN.—There was a very considerable immigration of Golden-crested Wrens on the Yorkshire coast in the third week of April. At Flamborough on the 21st they swarmed, and in the Spurn district were numerous on the 18th and subsequently, some being picked up dead, which fact is suggestive of a long and exhaustive flight. The wind during the period was strong north-east, and the weather was hazy. This movement of the Golden-crested Wrens is very remarkable, as, so far, we have no notice or record of a spring immigration of the species. We know that immense numbers arrive in October on our eastern shores at the same time as the Woodcocks, and that many again leave the country about the last week of March or early April at the same time when the Woodcocks are leaving. The spring movement is, however, much less observable, as these small wanderers then approach the coast in straggling fashion and not in the larger flights of autumn. Under unfavourable meteorological conditions I have known them congregate in considerable numbers in the coast hedgerows, biding their time. This spring immigration of Gold-crests has, probably, been caused by migratory flocks going north meeting with bad weather over the North Sea, driving them considerably westward of their normal route on to the East Coast of England.—JOHN CORDEAUX, Great Cotes House, R.S.O., Lincoln.

Notices of Books.

Corona and Coronet. By Mabel Loomis Todd. (Houghton, Mifflin & Co : Boston and New York.) Mrs. Mabel Loomis Todd has written a very charming account of the Amherst Eclipse Expedition, which went to Japan in 1896, to observe the total eclipse of the sun on the 9th of August. Mrs. Todd and her husband, Prof. David P. Todd, were the guests of Mr. James, who kindly placed his schooner yacht "Coronet," at the disposal of the observers in search of the "Corona," hence the title of the book. The author describes in an easy, conversational style, the preparations that were made to capture the fleeting light of the corona, and despite the fact that a faint mist intervened at the critical moment, yet her description of the veiled coronal light is a picture-poem in itself. To those interested in the coming total eclipse of the sun, in 1900, the book affords some idea of the preparations necessary in order to observe a total eclipse of the sun, and the trials that await those who propose to follow "in pursuit of a shadow." This unscientific account of a scientific expedition is treated in a masterly way by the bright, sympathetic author, who knows so well how to describe the picturesque scenes and people, and the many delightful experiences occurring during this eventful cruise. She weaves the charm of romance around actual facts, and a keen sense of humour adds greatly to the interest of the book. Mrs. Todd knows not only how to tell a story, but how to tell it well.

On Buds and Stipules. By the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S., etc. (London : Kegan Paul, Trench, Trübner & Co., Limited.) 5s. This new volume belongs to the deservedly popular International Scientific Series. That it is from the pen of Sir John Lubbock is evidence enough of its interest, even for the general reader. Vaucher long ago called attention to the fact that some species of rock rose have stipules while others have none, and suggested that it would be interesting to ascertain the reason for this difference. Sir John Lubbock has devoted himself to the question, and has been contributing his conclusions to the Linnean Society since 1890. In the present volume a selection of parts of the papers likely to be of general interest has been made. Every reader knows what a bud is, and the meaning of stipule is thus clearly defined by the author: "Stipules are normally more or less leaf-like structures at the base of, or just below, and one on each side of, the leaf-stalk. They are very variable in size and appearance" (p. 224). Among the conclusions arrived at may be mentioned that the general functions of stipules is to protect the younger leaves; their presence or absence depends in great measure on the need for such protection. Speaking generally, where the leaf-stalk is broad and covers the bud there are no stipules, and where it is too narrow to protect the bud stipules are present. But though the protection of the bud is the chief business of the stipule, it often performs other useful work. Sometimes it behaves like a leaf; often it forms hooks or tendrils; in other cases it secretes gum, or a sweet substance which attracts wasps; while in some plants it holds water—acts as a reserve of nourishment for the plant—or even makes a support for the stem. The book is lavishly illustrated at the rate of three good pictures to every two pages, and in addition to this there are four coloured plates. We cordially recommend the volume to "everyone who loves a garden," to use the words with which Sir John Lubbock commences. It is simply written in the author's well-known style, and many of the observations can be repeated by any intelligent reader.

Annals of the Lowell Observatory.—Vol. I. *Observations of the Planet Mars during the Opposition of* 1894-5, *made at Flagstaff, Arizona.* By Percival Lowell, Director of the Observatory. (Boston and New York: Houghton, Mifflin & Co., 1898.) Some six or seven years ago, M. Flammarion brought out an admirable monograph on the planet Mars, embodying the principal results of all the physical observations made upon the planet up to that date. Now we have in the first volume of the "Annals of the Lowell Observatory," a book of nearly four hundred quarto pages, and illustrated by twenty-one fine plates—nearly as large a book, that is to say, as Flammarion's monograph—as the result of the work of a single observatory during a single opposition. This in itself is a very remarkable achievement. It is the result of an adherence to the principle which Schiaparelli was the first to thoroughly exemplify; the principle of studying the planet, not just for a few weeks at opposition, but as continuously and as long as it was possible to do so with any good effect. To this principle Mr. Lowell added another. Before beginning his observations he made a most careful search for the most favourable site in which to erect his observatory. Schiaparelli, by his detailed and continuous observations in the fine climate with which he was favoured, revolutionized our ideas of the appearance of Mars, and carried its observation into quite a new sphere. In the main, his results have received ample confirmation. Mr. Lowell has carried areography into a higher sphere still. At present his results rest simply on his own observation and those of his two assistants, Mr. W. H. Pickering and Mr. Douglass. It would be unscientific, and eminently unjust, to reject his work because as yet it transcends the experience of less favoured, or less persevering observers. It would certainly be rash to accept them blindly until they have received support from entirely independent sources. In any case, Mr. Lowell's energy and perseverance, the thoroughness of his devotion to the study of this most interesting planet, and the lavishness with which he has devoted both money and personal effort, deserve the highest recognition and praise. The volume gives the observations made of the planet in great detail. An exceedingly minute survey of the South Polar cap affords incidentally a means for demonstrating in an ingenious manner the presence on Mars of air, water, and a temperature not incomparable with that of the earth. After some valuable determinations of a number of fundamental longitudes, follow measures of the diameters of the planet, giving a polar flattening of $\frac{1}{190}$, and, more remarkable still, a determination of the twilight arc of ten degrees as against eighteen degrees on the earth. The question of the seasonal changes on Mars is then worked out in great detail, but the bulk of the book is taken up with the study of "canals" and "oases." Mr. Lowell concludes that there is little water on Mars; that it is locked up in the South Polar snows during the southern winter, and that when liberated by the return of spring, it is led off by artificial canals, and distributed over the surface of the planet. The fine lines which we call "canals" are not these waterways themselves, but the zones of vegetation which spring up along their banks. An elaborate discussion of irregularities on the terminator occupies over eighty pages, the projections being ascribed to Martian clouds. These conclusions may or may not be verified in the future, but one result will certainly follow. It will no longer be considered sufficient for a great observatory to make ten or a dozen drawings of Mars at opposition as its contribution to our knowledge of the planet. Other observatories must give the same earnestness and energy to this study as has been done at Flagstaff, or they must leave it alone altogether.

Old Clocks and Watches and their Makers. By F. J. Britten. (Batsford.) Illustrated. 10s. net. Mr. Britten, already known as the author of several books, and as secretary of the Horological Institute, has here presented us with an account of the history of clocks and watches, their mechanism and ornamentation, to which is appended a list of about eight thousand old makers with descriptive notes. There are some four hundred illustrations, many of which have been reproduced from photographs of choice and curious examples of clocks and watches of the past, in England and abroad, including the finely-ornamented bracket clocks of the seventeenth century with their ingenious mechanism, and the tall and elegant cases of the eighteenth century; also a judicious selection of portraits of the most renowned masters of the clockmaker's art. Technical terms, so exasperating to people uninitiated into the mysteries of horological phraseology, are subordinated to the utmost, and are only allowed to show themselves when popular language is utterly inadequate to present an exact exposition of the subject in hand. One is, at first, puzzled as to how the author has been able to bring together such a vast collection of rare specimens of timekeepers, on which artists have lavished their resources in variety of design, and inventors their skill in all sorts of ingenious contrivances for self-winding, perpetual motion clocks, mystery clocks, rolling clocks, and so on, but the author, in addition to availing himself of the collections at South Kensington and the British Museum, has had access to many private collections, and has also elicited particulars not to be met with in ordinary channels, by consulting old tradesmen's cards, the Hon. Gerald Ponsonby, among others, having brought together a magnificent show of this kind. A very useful summary, in tabular form, of incidents connected with the development of clocks and watches is given, ranging from the invention

XUM

of weight clocks, attributed to Gerbert, 990 A.D., to duties imposed on owners of watches and clocks in 1797. Pitt, in that year, levied a tax of eight shillings an ounce on gold cases, and at the same time imposed a tax on all persons in respect of the possession and use of watches as well as clocks—an annual duty of two shillings and sixpence.

The Resources of the Sea, as shown in the Scientific Experiments to test the Effects of Trawling, and of the Closure of certain Areas off the Scottish Shores. By W. C. McIntosh, M.D., LL.D., F.R.S., etc. (London: C. J. Clay & Sons.) 15s. net. This handsome and well illustrated volume gives, with other important information, in a very readable form, an account of the work conducted by Prof. McIntosh for the Royal Commission on Sea-Fisheries (1883–85). A discussion of the results of these extensive researches also, very naturally, takes a place of considerable importance among the contents of the volume. The author, whose unique experience gives him a position of great authority, is unable to agree with the line of conduct of the Fishery Board for Scotland. This spirited criticism of the plans and conclusions of the Board will provide deep-sea naturalists, and students of the fisheries question in particular, with material enough for much serious thought, and a great deal of further experimental work. It is quite certain that the conclusions here set down will not be universally accepted by all specialists in this branch of technical biology, though we are equally sure that every chapter of the treatise will receive careful attention. Prof. McIntosh never leaves any doubt as to the points on which he holds his own opinion. Thus, on page 58, in referring to the closure of certain areas by the Fishery Board, he remarks: "No one will question the right of the Government to take such a step in the interests of the fishing population, on philanthropic, social, or even political grounds, but if such a step were taken on the basis of the scientific evidence furnished by the Fishery Board, then it would appear that the premises (and here all matters of fact are included) do not warrant the conclusion." Successive chapters are given to investigations of sea life by trawling in St. Andrew's Bay, the Frith of Forth, the Moray Frith, and the Frith of Clyde. Summarizing his remarks concerning the particulars to hand respecting St. Andrew's Bay, the author remarks: "If they show anything more than another it is that the closure of such areas has no appreciable influence on the increase or diminution of the fishes within their own boundaries or in the neighbouring waters. The problem is too vast to be solved by such pigmy measures" (p. 132). Again, in recapitulating his considerations of the trawling experiments in the Frith of Forth (p. 184), Dr. McIntosh declares that the conclusion of the Fishery Board "that there has been a decrease in the abundance of flat fishes in the closed waters of the Forth" rests on the most uncertain foundations, and is of little moment in dealing with so large a question. These selections are sufficient to show that there is much in this volume to be carefully weighed by every Fishery Board. The book contains a beautiful series of plates, including several views of the Gatty Marine Laboratory, St. Andrew's, pictures of various phases of a fisherman's life, a view of Aberdeen fish market, and many others equally interesting. Thirty-two tables of statistics furnish an invaluable appendix. Altogether the book is an important addition to applied marine zoology.

River Development, as Illustrated by the Rivers of North America. By Prof. I. C. Russell. (Murray.) 6s. The author has preferred to indicate by his title that his observations have been made in the country of magnificent streams where ample space permits the display of their capacious development, but it is evident that the same suggestive reasoning and acute observation must apply to the behaviour of the streams of all lands. Local conditions modify, but principles remain intact. One great fact that many of us may well learn from this interesting work, brightly and pleasantly written, is our own poverty of observation. There is a minuteness of detail worthy of consideration in the progress of stream sculpture that is apt to be overlooked without the assistance of an adept to call our attention to small niceties. Questions connected with the shape, the current, the banks, the eddies, and with the forces in action that are continually moulding and affecting the character, the development, and the behaviour of a small stream are many and far reaching. Another class of queries may come before us when carried on some commodious steamer over a broader river, past docks that tell of commerce and enterprise, out to the ocean beyond where a machinery of lighthouses and signals is necessary to enable us to avoid shifting sandbanks and accumulated material brought down by the river current. Unless we can explain all the facts that are brought to our notice between the source and the mouth of a river, we shall do well to pass an hour or two in the company of Prof. Russell. Many but by no means all of the questions which the river puts to us, or we put to it, he can and does answer pleasantly and satisfactorily. The illustrations, principally from photographs, make a very welcome addition to the pleasures of the text.

The Art of Writing English. By J. M. D. Meiklejohn. (A. M. Holden.) It is idle to set a limit to the ambition of a Scotchman. Not content with dominating the House of Commons and populating the learned societies, he has now (in the person of the genial professor of St. Andrews) launched this altogether admirable manual on the art of writing English at the head of the decadent Southron. It is badly needed, but we are quite sure it will not be studied by the men (or the women) who write; yet we may give expression to the fervent hope that the book will do something to thin the ranks of the muddleheaded among us. "Sir Thomas More was an Irishman. He was also a great lyrical poet. He soon gave up poetry, however, and went into the army. Shortly after he won the great battle of Corunna, in the Peninsular war. He was killed while walking about the deck with all his medals on: but he did not die ere he knew that he had won the great victory of Trafalgar." It would require a Kipling to do full justice—adjectival justice—to this muddleheaded study in black and white, but we feel it to be quite a moderate example of the mixed information which so largely serves to make our nationhood. And we wish Mr. Meiklejohn well in his heroic attempt to induce a little clear thinking across the border.

We have received *The Photo-Miniature*, a new American monthly magazine. (London: Dawbarn & Ward.) That there is room for another photographic magazine is a doubtful point. However, the *Photo-Miniature* is striking out on somewhat new lines, its aim being to supply "a sound general understanding" of any one section of photographic work. Judging by the one long and fairly exhaustive article before us on modern lenses this will be well carried out.

A second edition of *Chemistry for Photographers*, by C. F. Townsend, F.C.S., F.R.P.S., has been issued. A careful revision has removed the slight errors of the previous issue; a very useful book is the result.

The Open Court Publishing Company, of Chicago, have sent us some specimens of its projected series of portraits of the leading philosophical and psychological thinkers of the world. We think the idea an excellent one, and so far as the reproductions before us are concerned, it has been most efficiently carried out.

BOOKS RECEIVED.

Colour: A Handbook of the Theory of Colour. By George H. Hurst, F.C.S. (Scott, Greenwood & Co.) Illustrated. 7s. 6d.

Living Pictures: Their History, Photo-Production, and Practical Working. By Henry V. Hopwood. Illustrated. 2s. 6d. net.

All About Birds. By W. Percival Westell. ("Feathers" Publishing Co.) 1s. 6d.

Early Work in Photography. Second Edition. By W. Ethelbert Henry. (Dawbarn & Ward.) Illustrated. 1s. net.

Scientific Chemistry in Our Own Times. Prof. Tilden, F.R.S. (Longmans.) 5s. net.

Curious Epitaphs. By William Andrews. (Wm. Andrews & Co.) Illustrated. 7s. 6d.

The Use of Lead Compounds in Pottery. By William Burton, F.C.S. (Simpkin, Marshall, Hamilton, Kent & Co.) 1s.

The Geography of Mammals. By W. L. Sclater and P. L. Sclater. (Kegan Paul.) Illustrated.

Animals in Motion. By Eadweard Muybridge. (Chapman & Hall.) Illustrated. 20s. net.

The Choruses of Sophocles—"Antigone." By F. Abdy Williams. (Breitkopf & Härtel.)

Evolution by Atrophy in Biology and Sociology. By Demoor, Massart, Vandervelde. (Kegan Paul.) 5s.

Liverpool Observatory, Report of the Director for 1898.

Handbook of the Marriage Act, 1898. By M. Roberts-Jones. (Evan Rees: Cardiff.) 2s.

A Russian Province of the North. By Alexander Platonovich Engelhardt. (Archibald Constable & Co.)

Sport in East Central Africa. By F. Vaughan Kirby. (Rowland Ward, Limited.) Illustrated. 8s. 6d.

THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—IV.

By the Right Hon. Sir EDWARD FRY, D.C.L., LL.D., F.R.S., and AGNES FRY.

CAPILLITIUM.—It is impossible to consider the form of the sporangium without reference to the *capillitium*, *i.e.*, the system of hairs contained within it, and sometimes entering into union with it as part of its structure. This capillitium is often of great beauty. It is formed before the spores in the course of development, and it is probable that it performs a part in the dispersal of the spores. Sometimes, as in *Trichia* (Fig. 12), the hairs lie free amongst the spores. In this

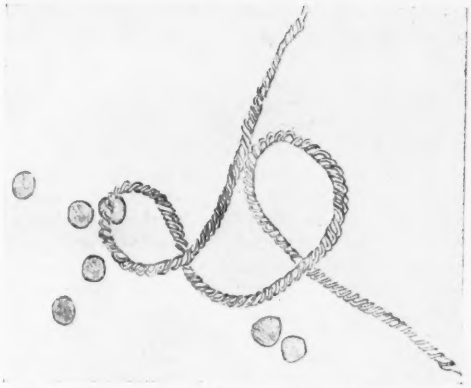


FIG. 12.—Elaters and spores of *Trichia varia*.

genus the hairs are furnished with spiral thickenings, which give them very much the appearance of a twisted cord, and they are hygroscopic, *i.e.*, under the influence of moisture they twist and twirl and thus separate and disperse the spores. In *Trichia* the sporangium opens by the bursting of the upper part of the case, and then the hairs, covered with the spores, pour out over the remaining part of the sporangium, so that it appears as if covered by a piece of delicate fur.

In some cases the hairs have not only a spiral thickening, but are furnished with projections, bristles or cogs of varying shapes. In one species, *Hemitrichia rubiformis*, the hair is so thickly beset with bristles that under the microscope it looks like the prickly stem of the bramble, and hence it derives its specific name. In some genera the hairs, as well as the spores, are remarkable for their bright golden yellow colour.

A connected system is presented by the capillitium of the beautiful genus *Arcyria* (Fig. 6). The immature sporangium is a long egg-shaped case standing on a pedicel; as it ripens the upper half or two-thirds of the membrane burst and fall off, leaving the lower part to form a cup (*c*), from which is seen to arise a thick web of fibres, almost like a pillow made of delicate horsehair (cap). These fibres are elastic, and so soon as the wall of the upper part of the sporangium gives way they expand to a height and breadth greatly in excess of the capsule in which they were contained. There can be little doubt but that these elastic fibres when mature must exert a great upward and outward pressure on the walls of the sporangium, and no doubt they hasten the disappearance of the upper parts of the wall.

In some species the system of hairs remains attached to the cup, which is the abiding part of the sporangium wall; in other species it is attached to the interior of the stalk only by a few branches, and then it is apt to fall away from its cup.

The likeness between the hairs of the sporangia of the genera *Trichia* and *Hemitrichia*, and of the *Jungermanniæ* is very close, and the same variety of arrangement is found in both cases. Both families exhibit elaters marked by spiral thickenings (*see* Fig. 12); but in the myxies these thickenings appear to be external, whilst in the Jungermanniæ they are generally, or always, internal. Both groups show differences in the number of these spiral thickenings; they are sometimes single (as in *Hemitrichia Wigandii*), or double, and sometimes reach to as many as six (in *Hemitrichia clavata*). In both groups the hairs are sometimes free and lie loose amongst the spores, and, in other cases, are joined together into a system—a regular capillitium, attached to the base of the sporangium. The *Jungermannia epiphylla* is a good illustration of such a regular system of hairs. In both groups the hairs or elaters appear to perform the same duties, of assisting by a pressure from within in forcing the sporangia open and of dispersing the spores by means of their hygroscopic activities.

In some sporangia, the most marked feature is a *columella*—*i.e.*, a prolongation of the pedicel, usually forming a column or a central line through the sporangium, but sometimes hemispherical and globose. In some genera it extends for only part of the height of the sporangium; sometimes for its entire height. A portion of such columella is seen in Fig. 13. To the columella the system of hairs is attached in many divers forms and ways. In *Lamproderma* the column reaches part of the way up the sporangium, and from near its summit it gives off a great mass of hairs spreading in every direction, so as to form a globe of anastomosing hairs. In *Enerthenema* the column is carried to the top of the sporangium, and spreads into a sort of capital, the top of which is part of the surface of the sporangium, and here the globe of slightly branching hairs is attached to the top, and falls down and fills the sporangium.

More complicated and more beautiful forms arise when the hairs branch out from all along the columella, and anastomose with one another so as to form a perfect network. In these cases the whole of the walls of the sporangium is supported by the ends of the hairs, and is usually very fugacious, and soon falls off, leaving a tree-like structure of delicate branches. The genus *Comatricha*

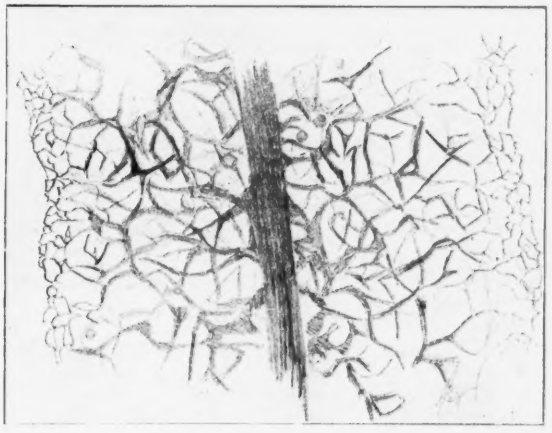


FIG. 13.—Capillitium of *Stemonitis fusca*.

shows round or ovoid heads, not unlike the system of branches of an oak (see Fig. 14). The genus *Stemonitis* has taller tree-like growths, which often remind one forcibly of a Lombardy poplar. Fig. 7 shows a group of sporangia. Fig. 13 shows a portion of the capillitium when the spores have been shaken out.

It is curious thus to see these similar forms assumed by the mighty trees and by their poor little and very distant relatives the myxies; and yet, perhaps, this similarity is not a mere accident, but the same physiological necessity has in each case produced the same result. In order that the leaves and flowers and fruit may be exposed to the greatest amount of sun and air, and that the fruit may be spread far and wide, it must be supposed that the tree-like form has been assumed. A globe suggests itself as the most natural form in which a solid mass can obtain an extensive exposure to the action of the sun and of the

FIG. 14.—Pedicels and Capillitia of *Comatricha obtusata*.

atmosphere if they operated equally all round. We say the most natural, as it would result from an equal and universal outward growth, but for the purpose of exposing its surface, the globe must be mounted on a stand; but as the lower part will be of less value than the top and sides, because less exposed to the action of the sun, it will be convenient that the globe form shall be modified: and this has been sometimes attained by horizontal, sometimes by vertical expansion. Some such physical necessities seem to have influenced the shape of trees; and similar ends are, we suppose, subserved by the dendroid forms of the capillitium in *Comatricha* and *Stemonitis*. How has the chasm between the need and the supply been filled up in these minute organisms or in the stately oak?

Another fact which creates further varieties in the form of the sporangia is the presence of lime in the capillitium and in the coats of the sporangium. In this presence of the carbonate of calcium in the sporangium, a character has been found for one of the subdivisions of the myxies, the so-called *Calcarineæ*. In some cases the lime is found in small grains in the substance of the covering membrane, in other cases it is found in star-shaped crystals lying on the outside of the membrane. These are very beautiful objects, and may both be seen in the genus *Didymium*.

In some cases the walls of the sporangium alone have the lime and the capillitium is without it; in many other cases the lime is found also on the capillitium, and that in different forms. We have already in our sketch of the life-history of *Badhamia utricularis* described the delicate lime structure of its sporangium.

Amongst all the delicate forms of the myxies there is none perhaps more beautiful than that of the genus *Craterium*. The sporangium, as the name of the genus is meant to tell, is goblet-shaped, and the top of the cup is usually covered with a distinct lid, which rests on the sides of the cup. In *C. pedunculatum* the colours sometimes suggest the notion of a golden cup with a silver lid, and in this dainty cup is found a capillitium of large white lime knots, connected by delicate hyaline or yellow threads, as shown in some of the broken sporangia of Fig. 8.

It has been suggested that the lime is to be regarded merely as an excretion, a thing of which the organism desires to be rid in its actively living parts. Be it so or not, it is evident that the organism sometimes continues to make this substance subserve the useful purpose of support.

It is worth while to note the several ways in which the capillitium appears to be used to attain the same end—the maturing and disposal of the spores. Sometimes it is the untwisting of the hygrometric spiral hairs which disperses them (as in *Trichia*, Fig. 12); sometimes it is the uprising of the elastic pillow contained in the sporangium (as in *Arcyria*, Fig. 6); sometimes it is by the spreading branches of the capillitium that the spores are scattered over a wide surface, as in *Enerthenema*; sometimes they are inelastic and charged with lime, and are then used as beams to prevent the walls of the sporangium from falling in and so injuring the young spores (as in *Badhamia*, Fig. 2). This wealth of plan, this variety of scheme for effecting the same end, and with the same or nearly the same materials, is not unfrequently found in the works of Nature. One might suppose, if Nature were striving to do the one thing needful with the utmost economy, and in the very best way, that there would be one, and only one way which was the cheapest and best, and that this would, on the principle of the survival of the fittest, be found everywhere to prevail. But this is by no means always the case. Look at the vast variety of schemes by which, in orchids, insects are made to solve the problem of getting the pollen-masses out of the boxes into which they have been stowed away, and then of pollinating with them the stigmatic surface. Or look again at the vast variety of the forms of the peristomes in mosses (all varieties of the same elements and of the same fundamental idea), and the various ways in which they operate under the action of moisture. Or take again the insectivorous plants. Here the problem which Nature seems to have set herself is this—given a leaf, how to catch insects? And this problem has been solved by the use of different constituent parts of a leaf in almost as many ways as there are genera of insectivorous plants. Or, once more, take the case of birds fitted for subaqueous locomotion. Here the problem seems to have been—given wings and legs, how to drive the body through the water? and this has been solved, as we know, sometimes by using the wings, sometimes the feet, as paddles, and with a wealth of variation that is very remarkable. In all these cases Nature seems not to ask herself what is the single best way of using the instruments at command, but, given certain organs, how to attain the end in view with the greatest amount of variation!

THE OPENING OF THE SPORANGIA.—In some cases, as already mentioned, the sporangium opens by an indeterminate rupture, in other cases Nature differentiates it into two parts, the upper forming sometimes a lid, as in *Craterium*, sometimes falling away early, as in *Arcyria*. Just the same kind of difference prevails, it will be remembered, in the mosses, the sporangia of the clay

mosses (*Phascum*) opening by a decay of their sides, the sporangia of most of the moss on the other hand having a regular dehiscence.

It is a beautiful sight to see through a microscope the opening of a sporangium of a myxie under the warmth of the sun. We have watched it in the *Trichia fallax;* sometimes there appears a small hole in the membrane towards the top, which enlarges into a chasm; sometimes the whole upper part seems lifted or pushed up. Then the closely-packed spores begin to start out—one after the other—falling at varying distances; then the whole surface of the mass of spores and elaters begins gently to heave and move, and the elaters sway about like the arms of a polype. These actions are, we presume, due partly to the elasticity of the hairs seeking to expand in every direction, and partly to the unequal thickness of the parts of the elaters and the consequently unequal action of the heat on the elaters themselves. They curl and twist because they are unequally expanded.

SPORES.—The spore is another part of the structure which varies much. Spores vary in size; they vary in colour, sometimes violet or brown, or red or yellow; they vary in their surface, sometimes smooth, sometimes spinulous or covered with warts; sometimes covered with a kind of network or furnished with a border or band. All these variations are used as points of distinction in the classification of the myxies, and the presence of a dark violet colour in the species is found, as already mentioned, to be of high classificatory value.

Another curious point about spores is the tendency in some of them to gather into groups of a more or less definite number, whilst others exhibit no such tendency, but remain single or aggregated without law. The spores of *Badhamia utricularis* have a tendency to gather into groups of from seven to ten, whilst the spores of its nearest congener, *Badhamia hyalina*, often congregate in numbers as high as twenty, and in other closely allied forms the spores are free. But this character, though generally true, is not absolutely constant. The spores of *B. hyalina* are sometimes almost free, and the same tendency to variation has been observed in other species.

ELECTRICITY AS AN EXACT SCIENCE.

By HOWARD B. LITTLE.

IV.—EXPERIENCE, ITS VALUE, AND ITS DANGER.

SINCE electricity has become so great a factor in our daily lives, the experience of every man, woman, and child, throughout every civilized country in the world, has been enormously widened; or opportunities have been constantly given for such widening. Nor is this all; the far-reaching "fluid" is exercising a distinct influence on the savage. But it is sufficient for our present purpose merely to note this fact, without entering upon any discussion of it.

It will not be too much to assert that the popular use of electricity has introduced a new order, or class, of experience. This seems a painfully trite remark when one considers that every business or profession requires its own specially-trained workers; but what may be termed here "electrical experience" exhibits such a characteristic series of features that its consideration, besides being of interest, should also be profitable. To commence with, the idea of its being possible, by the motion of a relatively tiny lever here, to send messages to the Antipodes, seems to have opened up a new field of thought, which has in a manner been cultivated by the public's reception of such messages here, for the public is straining daily to live at a greater rate, to receive its news more rapidly, and to travel faster. To all this it is the electrician's business to attend. As typical instances of the kind of task he should set himself may be mentioned the attainment of a higher speed in signalling, and an increase in the number of messages which, at one time, may be sent through the same line. The latter consideration will, as a rule, resolve itself into a question of maintaining the absolutely synchronous motion of two instruments at opposite ends of the line.

Another point for his consideration is the maintenance of absolute regulation of supply to light and power mains. The question of fuel economy may very well be referred back to the mechanical engineer, because the efficiency of a good dynamo is generally some six or seven times as great as that of a good steam engine; in fact, as it has so often been pointed out, an enormous percentage of the fuel is wasted between the stoker's shovel and the pulley of the dynamo.

Unfortunately, man is not endowed with an electrical sense; he has to rely entirely on experience to ascertain the presence of electricity. And in some instances it is wonderful with what rapidity such experience can be brought into play. To quote a simple instance, and one of every-day occurrence. Suppose a house be "wired" and connected with an alternate-current station. The shock to be obtained from the fuse connections, or any similar points on the circuit, would be quite sufficient to startle anyone unaccustomed to such shocks, and should such an individual be at the time upon a ladder, it is quite possible that he would tumble off. Yet, to the electrician it is nothing, because, brief as the contact would in all probability be, he has yet had time to bring his experience to bear, before giving the involuntary jump.

Again, it is electrical experience alone which can enable us to rapidly grasp all the details of a system of electrical connections, which may involve the use of dozens or hundreds of connecting wires. And the ideas of self induction and mutual induction seem to the layman a complete upsetting of all his preconceived notions, while he is further appalled to learn that he will have to regard these as existing in definite quantities, under definite conditions; and in consequence subject to mathematical investigation. But, just as some "hyper-mathematical" minds have a conception of a fourth dimension, even so is this amongst electricians, in that to some these quantities assume a far more concrete entity than to others.

Turning now to quite another class of experience which the electrician must cultivate. He is called upon, more than any other scientist in these times, to explain to the non-scientific public. The less intelligent section of this latter community will, as a rule, be quite satisfied that they thoroughly understand the working of any apparatus if once they have been informed that it is electrical; and under certain circumstances it becomes the electrician's painful duty to undeceive them, and, with all the tact at his command, to insinuate that they really know nothing whatever about it. On the other hand, there is the individual who wants to know, and who will ask questions. In this connection the average electrician suffers more than all the members of any Foreign Office ever constituted, for two reasons; first, he is expected to make clear, to the class of questioner aforesaid, in the course of a few instants, what it may have taken him many years to arrive at a just appreciation and understanding of; and secondly, because the lay mind, having from childhood been familiarized with the phenomena of light, heat, and sound, never realizes that it has no information whatever as to what they are; consequently, by some curious process of reasoning, or want of reasoning, the impression

prevails that any electrician who knows his business should be able to tell at once what electricity is. In this connection our esteemed contemporary "Mr. *Punch*" did us a great service many years ago, when, representing himself as having been asked to state what matter was, he replied somewhat in this way, "Matter, matter. Ah! yes, matter. Well, its—well, no matter." But "Mr. *Punch*" has many privileges to which the humble tramp toiling on the road of science is in no way entitled. Yet, seriously, it *is* a serious matter. Only a short while back I was asked, by a man whose intelligence I consider much above the average, "What are X rays? I want to make some." And there is yet another phase of this trouble. The "man in the street" clings to certain ideas, cherishes them, and absolutely refuses to part with them. For example, it is quite impossible to prevail on the majority to abandon their deep-rooted conviction that the phonograph is an electrical apparatus. In short, it will be noted that so far as these points alluded to are concerned (and indeed with reference to many others) the electrician requires, and must cultivate, a certain class of experience which is to a great extent unknown in other callings.

But nothing we can mention in this world is an unmixed blessing. While speaking of experience we must bear in mind that at times it may (under suitable conditions) become a distinct source of error. Reverting to first principles, under ordinary conditions of life we are justified in saying that where we can neither see nor hear nor feel the presence of anything, there is nothing present. We are so used to the ubiquity of the mixed gas air, that we do not trouble ourselves to mention it, and so we have such an expression as "an empty box." This is hardly to be regarded as contempt due to familiarity, but rather as an error, introduced by too wide an experience. Similarly, the student of electrical science has to be brought to realize that even though he cannot see, hear, or feel electricity, yet it may be present, and he has, as already pointed out, to look for its effects rather than for it.

While it is possible for electricians to learn a great deal from their failures, yet it frequently happens that the next undertaking of a similar nature to that which was not successful is approached with a distinct want of heart, and it will scarcely be too much to state that every electrical failure which comes to the knowledge of the public exercises a most pernicious effect upon them. Witness the trouble experienced in order to capitalize the earlier Atlantic cables, and note that the Royal Albert Hall, of which Londoners are justly proud, is not yet electrically lighted. Further, the public having noticed certain electrical failures have adopted the catch words "That shows the difference between theory and practice." For this there are two causes, they mis-apply the experience they have, and overlook the fact that any idea which works out satisfactorily on paper, but not in practice, had some essential point or points omitted in its theoretical consideration, or "on paper."

There exists a most unfortunate tendency to consider parrot, or monkey-like, imitation an exercise of experience, if not of the imitators at least of some constituted authorities. Also, there is great and serious liability to error from the fact that statements by such authorities are frequently very badly reported where things electrical have been spoken of. Speaking of imitation, it is almost amusing to observe that municipal bodies are now adopting very frequently a curious precedent with reference to electrical undertakings. Having decided to install the electric light, or to undertake the construction of an electrical tramway, the body in question will depute some two or three of its number to go and inspect the system or systems in use by other such bodies. Speaking gently of this practice one is bound to admit that it seems clumsy and expensive.

When the results achieved by Tesla, Röntgen, and Marconi were first announced the majority of electricians found that to become thoroughly conversant with their full import it was actually necessary to abandon many of their preconceived ideas, and even then, what they had been led to regard as well-founded conclusions, derived from past experience, still formed something of a stumbling block. Similarly, an electrician who has become thoroughly used to direct-current work will, if he suddenly find himself called to undertake investigations with reference to alternating currents, for some time to come find much of his past experience (though perfectly accurate in so far as it went) a decided nuisance to him, for the time being at least. It might be urged that these latter instances tend to show the danger arising from incomplete experience, rather than the danger of certain experience; but this contention cannot be allowed, for, returning to one of our previous illustrations, the error which usage permits in the expression "empty box" is not due to the fact that we have no experience *in vacuo*.

Perhaps of all the errors into which electricians as a body have ever fallen, solely on account of commercial-electrical teaching or experience, the one most widely spread was that which led them (well within the past ten years) to deride the teaching in schools of "frictional electricity." It used to be said that to teach a boy what would happen when silk, or sealing wax, or glass, was rubbed, was a mere waste of time, because it was not the electricity of commerce. It was pointed out that "frictional electricity" had but two commercial applications, for it was only made use of to de-electrify silk, when in the process of manufacture it became electrified, and hung together, with a tendency to become entangled, and to electrify the ink contained in the telegraphic syphon recorder. When, later on, this latter field for the remunerative use of the despised form of electricity was no more (owing to the introduction of a clockwork tapping apparatus which was found more convenient as a means of making the ink "jump" out of the tube), the electrician's tolerant smile at the "science master" became something painfully like a grin. But all that has been changed by the three men just mentioned (purposely in conjunction, though their work has been independent, and productive of widely different results). Before leaving this point, let me confess that I personally did my best to become one of the broadest grinners at the "science master." All I can say in extenuation is that, having cultivated a certain class of experience, I fell into the pit which I had dug unconsciously for myself, and, arrived at the bottom—well, I had good company there. Yet the value of experience must be by no means under-rated. Perhaps the plain statement of fact is best expressed by the assertion that amongst electricians, particularly, it requires great experience to arrive at a just appreciation of the value of experience, and a wide experience to make a proper use of experience.

THE TEETH ON THE LABELLA OF THE BLOW FLY.

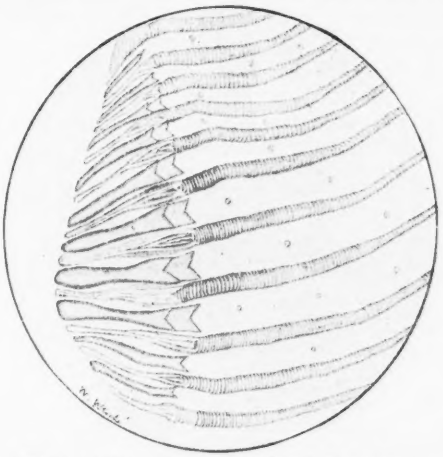
By WALTER WESCHÉ.

ONE of the most familiar objects that is mounted as a slide for the microscope, is the proboscis of the Blow Fly (*musca vomitoria*). Probably the most modest collection of objects contains a slide. It is used every day as a test for low powers, for flatness of field and sharpness of outline, and even familiarity has

not diminished our wonder and admiration of this marvel of minute structure. But in the vast majority of cases, if a microscopist is asked to show the teeth, a denial of their existence would be received, probably coupled with an assurance (as I have been assured) that there were no teeth, but some minute hairs on the edge of the labella which had been mistaken for them. It is a curiosity of microscopy that often, unless it is known what to look for, it is quite possible to miss seeing a structure or detail, from the fact that its focus is at a different distance from some near, yet more prominent object. This is precisely the reason, coupled with the fact, that the proboscis is usually looked at with low powers, why these teeth escape observers; they lie at the base of the false or pseudo tracheæ, at a different focus, and the chitine of which they are composed being a light yellow and transparent, they are easily overlooked.

Like the teeth of the Dung Fly (*Scatophaga*), they were discovered by Mr. W. H. Harris, and figured in *Science Gossip*, in 1885, but the discovery seems not to have become known out of a small circle—as it is mentioned as fresh in the *Journal of the Royal Microscopical Society*, in July, 1898.

The teeth show between eleven of the false tracheæ, and six appear to be double, making a total of sixteen on each labellum. With the exception of one at the end furthest from the head, they have a cleft edge, thus securing two points to each tooth, and, one might suppose from this, are used for pricking or gently scraping a surface, possibly with the object of accelerating a flow of liquid. They are much thinner than those of the *Scatophaga*, and not round



Teeth of Blow Fly, magnified 170 diameters.

and tooth-like, but riband-like in appearance. The bases appear slightly rounded, and from these the teeth broaden and taper to a very thin edge—they might be compared to a row of chisels with cleft edges.

To see them a magnification of three hundred and fifty diameters is quite sufficient—a good quarter-inch power would do; the field at the back of the teeth is rather obscured by the chitinous support of the labellum, but if the bases of the false tracheæ are focussed, the characteristic edge of a tooth is probably seen, and that once found, the rest is easy. The length of the row of teeth is three two-hundredths of an inch.

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

The embedding of soft tissues requires considerable skill on the part of the operator. But frequently, notwithstanding the greatest care, failure results, either owing to the variable nature of the medium used, or because the processes of hardening have been too protracted. Those who have experienced these difficulties should try the white of an egg as the embedding medium. The process is as follows:—Make a small paper box, about a half-an-inch square, and fill it with the white of an egg. Eliminate all alcohol from the material which is to be mounted, and embed it in the albumen. Expose the box and its contents to heat, and when hardened place it again in alcohol. If the sections are passed through oil of cloves with balsam, the albumen will become clear and transparent.

An illustration of the pitfalls that confront science students is given by Dr. Martin Ficker, a German bacteriologist. Among various sources of error in work with bacteria is the glass of the vessel used, as different kinds of glass impart varying degress of alkalinity to water, and it is found that some bacteria, notably those of cholera, are favourably affected by alkalinity. This novel cause seems responsible for marked and important discrepancies.

Freshwater mites do not, as a rule, make satisfactory mounts. They shrink and fade, thus losing in the preserved state the beautiful symmetry and colourings which render them, when alive, such charming objects for observation and study. The difficulty is the mounting medium. No formula is known which will give perfectly satisfactory results, but the following, if carefully prepared, will enable the microscopist to preserve his specimens, for some years at least, from bleaching and collapse:—Prepare three mixtures of distilled water and pure glycerine in the proportions of twelve parts, ten parts, and eight parts of water, respectively, to one part of pure glycerine, and to the last add a small drop of carbolic acid. Place the specimens in the twelve-part mixture and leave them for twelve hours, after which place them in the ten-part mixture and leave them for a similar period. They may now be permanently mounted in the third mixture. Solid glass cells are preferable to built-up ones.

The preservation of labels of reagent bottles is a frequent source of trouble to the working microscopist. A good varnish for this purpose may be made by macerating the following substances, and thoroughly shaking the mixture until all are dissolved:—Sandarac, sixty parts; mastic, twenty-five parts; camphor, one part; oil of lavender, eight parts; Venice turpentine, four parts; ether, six parts; and alcohol, forty-four parts.

It is frequently desirable to supplement the records obtained by photographing micro-sections with a drawing, and it would probably be oftener done were it not for the difficulty that many experience when using either the neutral tint reflector or the camera lucida. With a vertical camera and suitable tracing paper this difficulty disappears, and it is possible, after a little practice, to acquire a creditable amount of dexterity in representing the salient features of all objects that do not require high-power objectives for their delineation. In making such drawings it is a great advantage to be able to do them direct from the microscope, so that no transference or copying is afterwards needed. For this purpose, the following recipe for making a tracing paper, which can be re-converted into ordinary drawing paper after the drawing has been made on it, will be found to be both simple and effective:—Immerse any ordinary drawing paper in a mixture consisting of one volume of castor oil and three volumes of spirits of wine, and hang it up to dry in a warm room for two or three hours. Place a sheet in the focussing screen of the camera and make the drawing, after which place it in a bath of spirits of wine and allow it to remain there until the oil has been dissolved out. The paper will resume its former state and appearance.

The isolation of the skeletons of siliceous organisms, foramens, and other small objects from rock specimens, may be readily effected by first drying the rock in air and then dropping it into a hot, saturated solution of Glauber's salts. On cooling, the processes of crystallization break up the rock mass.

Balsam mounts are apt to deteriorate, unless some means are adopted to prevent the access of air or moisture. They may be protected by running a ring of melted paraffin wax around the

edge of the cover-glass, by means of the turn-table, and afterwards, when set, protecting this in its turn with a ring of finishing cement. A very beautiful and instructive preparation may be made by heating xylene balsam on a slide until the xylene has almost evaporated, and then adding a few crystals of sulphonal. The preparation should be gently warmed until the sulphonal melts and mixes with the balsam. The cover-glass is then put on. If perfect crystals are obtained this mount will show, with the aid of the polariscope, not only the most gorgeous colourings, but also perfect examples of the black cross.

An ocular pointer is a useful accessory for class demonstrations when it is desired to indicate any particular structure or object in the field of view. To make one, cut out a circle of cardboard of a size sufficient to fit easily in the ocular tube. Out of the centre of the circle punch a second circle, having a diameter slightly larger than that of the ocular diaphragm. Blacken this cardboard ring, and, with a little gum, fasten an eye-lash to edge of the smaller circle so that the *cilium* shall project halfway across the opening. Remove the eye-lens of the ocular, and drop the cardboard ring into the tube so that it rests on the diaphragm. The *cilium* is now at the level of the real image, and the specimen on the stage of the microscope can be so placed that the pointer will indicate exactly any particular portion to which it may be desired to draw attention.

Alcohol is used by many microscopists both for killing their specimens and for preparing them for the laboratory and museum. In the case of marine animals the use of alcohol in inexperienced hands is often attended with unsatisfactory results, and this for several reasons. On thick-walled animals, particularly those provided with chitinous envelopes, this reagent acts prejudicially on the internal organs, while in the case of the smaller crustacea it gives rise to precipitates in the body fluids which frequently prevent a satisfactory dissection of the parts being made. It has also been found in practice that alcohol tends to fix the salts of the sea-water contained in the organism, and thus, by forming a crust, prevents both the hardening and the staining fluids from penetrating the tissues. With proper precautions there are, however, few reagents which give better results. The method employed in the Marine Biological Laboratory at Naples is worth the attention of those whose efforts with alcohol have not always been so successful as they may have desired them to be. To kill, let us say, an annelid, the animal is transferred to a beaker containing sea-water. A few drops of alcohol are added, and this is repeated at short intervals until the animal expires. This tentative method of killing neither causes contraction nor distortion of the parts. The animal dies slowly, and, when dead, is so supple that it may be readily arranged in any desired position. The main point is to avoid the mistake, usually made, of killing in strong grades of spirit. After death the specimen may be passed through the various grades of alcohol in the usual way.

The popular theory regarding "honeydew" is that it is an excretion from aphides. Mr. H. W. Brice has recently made a microscopical examination of the substance, and has arrived at the conclusion that the popular theory is fallacious. Under the microscope some thickly-coated leaves of the lime and sycamore revealed not more than three or four insects per leaf. These insects were removed, and an hour afterwards the beads of honeydew were found to be more numerous and larger than when the leaves were first gathered. He concludes, therefore, that the leaves of some trees, under favourable climatic conditions, become surcharged with saccharine matter, and, the cells bursting, a copious exudation of "honeydew" takes place. The fact that "dew" gathered from the sycamore and the oak is much darker than that from the lime is held to prove that it partakes of the nature of the tree and not of the insect.

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

SWIFT'S COMET.—In June this comet travelled in a direction which carried it rapidly away from the earth, and in July it will only be visible in powerful instruments. At the opening of the latter month the comet will be situated a few degrees S.E. of Arcturus. The following ephemeris is by Dr. A. Stichtenoth (*Ast. Nach.*, 3574) :—

Date.	R.A. h. m. s.	Dec.	Distance in Millions of Miles.	Brightness.
July 2 ...	14 20 38	+ 19° 39·3′	117	0·13
,, 6 ...	14 16 54	+ 17° 16·5′	129	0·11
,, 10 ...	14 14 20	+ 15° 13·0′	140	0·08
,, 14 ...	14 12 43	+ 13° 24·9′	152	0·06

The comet has shown some extraordinary fluctuations in brightness. On June 4th and 5th it was estimated one magnitude brighter than on June 3rd. The sudden increase was noted by Mr. T. H. Astbury, of Wallingford, and it is also referred to in *Ast. Nach.*, No. 3574, by Hartwig Schorr, Holetschek and Pokrowski.

TEMPEL'S COMET (1873 II.)—This object is now favourably visible and rapidly increasing in apparent brightness. It is, however, moving to the S.S.E., and will be somewhat low in the sky as observed from our latitude. Ephemeris by L. Schulhof :—

Date.	R.A. h. m. s.	Dec.	Distance in Millions of Miles.	Brightness.
July 3 ...	20 18 43	− 10° 1′ 5″	40	2·77
,, 7 ...	20 23 45	− 11° 38′ 27″	38	3·01
,, 11 ...	20 28 41	− 13° 27′ 12″	37	3·23
,, 15 ...	20 33 53	− 15° 25′ 46″	36	3·42
,, 31 ...	20 52 41	− 24° 7′ 36″	35	3·67
Aug. 4 ...	20 57 26	− 26° 14′ 6″	35	3·59

The comet will, therefore, be placed in the northerly region of Capricornus early in July.

HOLMES'S COMET.—This interesting body ought to come under observation in July if serious changes have not affected its appearance or orbit since its apparition of 1892. In *Ast. Nach.*, 3553, Zwiers gives the following sweeping ephemeris :—

Date.	R.A. h. m. s.	Dec.	Brightness.
July 3 ...	1 51 41	+ 24° 7′	0·0374
,, 7 ...	1 57 53	25° 17′	0·0382
,, 11 ...	2 3 59	26° 26′	0·0390
,, 15 ...	2 9 56	27° 34′	0·0398
,, 31 ...	2 32 10	+ 32° 2′	0·0435

The brightness of the comet in 1892, November 8th, is adopted as 0·0747. On July 9th its position will be three degrees north of the bright star α Arietis, and its motion will carry it slowly to the north-east.

Since the above was written, information has come to hand that Holmes's comet was re-discovered on the morning of June 11th by Perrine, at the Lick Observatory, and that its position differed very little from that given in the ephemeris by Zwiers.

TUTTLE'S COMET.—This object is now invisible to observers in the northern hemisphere. During July it will travel rapidly to the south-east, and on the last day of the month will be in R.A. 10h. 10m. 14s., Dec. 30° 54′ south.

Fireball of 1899, *April 4th.*—In our notes for May reference was made to this object as observed at Birmingham and St. Anne's-on-Sea. It was also seen at Chester, and though the several observations are not in good agreement it is certain that the meteor was a brilliant Virginid, the radiant being at about 202° − 10°. The length of its real path was about one hundred and sixty miles from a height of sixty miles above a point ten miles west of Whitehaven to fifty-two miles above the north coast of Ireland.

Fireball of 1899, *June 2nd.*—In the strong twilight prevailing at about 8h. 47m. on June 2nd, a very fine meteor was observed from several places in the West of England. Few stars were visible at the time, so that the path of the object would not be exactly determined. Mr. Thomas Harries, of Llanelly, describes the meteor as rivalling Venus, and says its path was directed from Leo towards due west, extinguishing there at a point about thirty degrees above the horizon. The duration of flight was four seconds. At Bridgwater the object was seen by two persons, from whose description immediately afterwards Mr. Corder placed the beginning near β Leonis and the end close to the N.W. horizon. Its brightness was estimated as four times that of Jupiter. At Weston-super-Mare the meteor was seen as "a clear electric ball travelling quite slowly in a direction from east to west, and descending gradually until it seemed to go out." It was visible for two or three seconds, and appeared not very high in the heavens. It was also seen at Bristol and some other stations, but the descriptions are not very exact as regards details. It is certain, however, from a comparison of

the various accounts of the meteor, that it belonged to a very well defined radiant of midsummer fireballs in Scorpio. It had a long and nearly horizontal flight (similar to that of the fireball of April 4th last), and beginning over the region of Totnes, Devon, it passed to north-west and disappeared over St. George's Channel after a course of about one hundred and seventy miles, during which it descended from sixty-one to fifty-one miles above the earth's surface. The radiant was approximately at 250° – 23° a few degrees north-east of Antares.

Large Meteors.—On 1899, May 27th, 8h. 53m., Mr. T. H. Astbury, of Wallingford, saw a fine meteor about three times as bright as Jupiter. Its path was from 246° + 26° to 252° + 16°. It moved swiftly and died out suddenly without an explosion. On 1899, May 28th, about 10h. 30m., a bright meteor, giving a flash at its disappearance, was noted by Mr. Corder at Bridgwater. It passed over κ Herculis and was directed downwards from half-way between β and ζ Herculis. Fine meteors were also seen on June 1st, 9h. 20½m., at Kettering, and on June 5th at Wallingford.

The great Perseid meteoric shower usually begins in the second week of July, and by the end of the month often becomes fairly prominent. During the years from 1869 to 1898, and periods from July 12th to August 20th, the writer at Bristol observed 6479 meteors, of which 2409 were Perseids, and the place of the radiant was determined on seventy-three occasions. An average of these was recently deduced, and indicated the position in July as follows :—

		°	°		°	°
July 13	...	13·5	+ 48·6	July 25	...	26·2	+ 52·8
„ 16	...	16·6	+ 49·8	„ 28	...	29·6	+ 53·6
„ 19	...	19·7	+ 50·9	„ 31	...	33·2	+ 54·4
„ 22	...	22·9	+ 51·9	Aug. 3	...	36·7	+ 55·2

It will be seen that in July the R.A. of the radiant nearly corresponds with the day of the month.

THE FACE OF THE SKY FOR JULY.

By A. FOWLER, F.R.A.S.

THE SUN.—On the **1st** the Sun rises at 3.49, and sets at 8.19; on the **31st** he rises at 4.23, and sets at 7.49. He is at his greatest distance from the earth on the **4th** at 9 A.M., his apparent diameter then being the smallest possible, namely 31′ 30·6″.

THE MOON.—The Moon will be new on the **7th**, at 8.31 P.M.; will enter her first quarter on the **15th**, at 11.59 P.M.; will be full on the **22nd**, at 9.42 P.M.; and enter her last quarter on the **29th**, at 0.43 P.M.

The brightest star occulted during the month will be 7 Sagittarii, magnitude 5·4, on the **20th**; the disappearance takes place at 7.39 P.M., at 58° from the north point (80° from vertex), and the reappearance at 8.41, at 297° from north point (310° from vertex).

THE PLANETS.—Mercury is an evening star throughout the month, being at greatest eastern elongation of 26° 59′ on the **22nd**, and at aphelion on the **27th**. In spite of this great angular distance from the Sun, however, the planet at greatest elongation will only remain above the horizon at London for about an hour after sunset, and the prolonged twilight will interfere with naked-eye observations. On the evening of the **25th** he will be a little more than 2° to the south of Regulus.

Venus remains a morning star, badly placed for observation. She rises little more than an hour before the Sun, and has an apparent diameter of only 10·3″. More than nine-tenths of the disc will be illuminated.

Mars has almost passed out of our view, setting very shortly after 10 P.M. at the middle of the month. On the **1st** he lies to the south-east of Regulus, and during the month describes a path towards β Virginis, a star which he very closely approaches on the evening of the **29th**. His apparent diameter is 4·8″ on the **15th**.

Jupiter remains an evening star, and will be found in Virgo, roughly midway between Spica and α Libræ. He will be in eastern quadrature on the **24th**. He crosses the meridian on the **1st** at 7.16 P.M., and on the **31st** at 5.24 P.M., setting about half-past eleven on the latter date. The low altitude of the planet, combined with long twilight, renders the position rather unfavourable. On the **15th** the polar diameter is 35·2″. At convenient hours the satellite phenomena are most interesting on the **7th**, **8th**, **13th**, **15th**, **16th**, **18th**, **25th** and **31st**.

Saturn remains in the southern part of Ophiuchus, between the stars η and ϑ of that constellation, and remains visible until after midnight throughout the month. He is due south at Greenwich on the **1st** at 10.33 P.M., on the **15th** at 9.35 P.M., and on the **31st** at 8.29 P.M. On the **15th** the polar diameter of the planet is 16·8″; the outer major and minor axes of the rings are respectively 41·9″ and 18·8″; while the axes of the inner bright ring are respectively 26·7″ and 12·0″. The rings are widely open and the northern surfaces are visible.

Uranus remains in Scorpio, almost midway between ν Scorpii and ρ Ophiuchi. He will be due south on the **1st** at 9.32 P.M., and on the **15th** at 8.36 P.M. The apparent diameter is 3·8″ and the movement is westerly.

Neptune is too near the Sun to be observed.

THE STARS.—About 10 P.M. at the middle of the month, Perseus, Andromeda and Cassiopeiæ will be in the north-east; Cygnus and Pegasus in the east; Aquila in the south-east; Lyra nearly overhead; Corona, Libra and Virgo in the south-west; and Ursa Major in the north-west.

A favourable minimum of Algol will occur on the **13th** at 9.51 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of June Problems.

(By W. S. Branch, Cheltenham.

No. 1.

1. B to B6, and mates next move.

No. 2.

Q to R8, and mates next move.

CORRECT SOLUTIONS of both problems received from J. K. M. (Repton), Capt. G. A. Forde, K. W., D. R. Fotheringham, H. S. Brandreth, N. B. Dick, W. Clugston, G. C. (Teddington), H. Le Jeune, N. M. Munro, J. Baddeley, many of whom have greatly admired these two problems.

Of No. 2 only, from Alpha, E. Servante, A. H. Doubleday, W. de P. Crousaz, W. Nash, A. T. Laster.

[Most of the above have given 1. B to B3 as the key of No. 1, overlooking that after 1. . . . R to B5ch, 2. K×R (dis. ch.), the Black Pawn can interpose.]

Alpha.—If it were not for the check !

E. Servante.—If 1. KtP×P, the Black Bishop moves.

Percival K. Hogg.—A little examination will convince you that none of your solutions to No 1 will quite work.

W. Nash.—Very glad to hear from you. You are in good company with "Alpha."

Rev. E. Cowley.—Thanks for the problem, which I have

not yet had time to examine. If sound and good, it will receive early publication.

W. Clugston.—Thanks for the two problems, which shall be examined shortly.

J. K. M. (*Repton*).—Problem withdrawn as requested. The other two appear below.

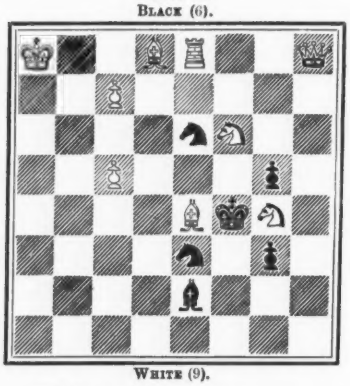
Towers.—In No. 2 the Black Pawn can cover. There is a solution to No. 1, as you will see above. It is difficult to apply the method of exhaustion to a chess problem, unless the process is absolutely complete.

PROBLEMS.

By J. K. Macmeikan.

No. 1.

BLACK (6).

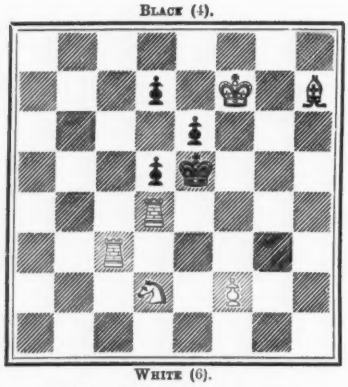


WHITE (9).

White mates in two moves.

No. 2.

BLACK (4).



WHITE (6).

White mates in two moves.

CHESS INTELLIGENCE.

The Kent Chess Association inaugurated a successful congress during Whitsun week. Messrs. Blackburne, Gunsberg, Lasker, Pillsbury and Tinsley, took part in simultaneous and blindfold displays, and in some consultation games, in which Mr. Pillsbury was both times on the winning side. The Kent Cup was won by Mr. P. Hart Dyke, the well-known Cambridge University expert, who from necessity plays *sans voir*.

Those insatiable opponents, M. Janowski and Mr. Showalter, have arranged yet another match to take place next October. Meanwhile both are playing well in the London tournament which commenced on May 30th.

The entries in the two-round tournament are not quite so representative as was hoped. Notable absentees are Dr. Tarrasch, M. Charousek, and Herr Lipke. Mr. Burn entered but declined to play. The competitors are Lasker, Janowski, Pillsbury, Maroczy, Cohn, Schlechter, Showalter—who are at present ahead of a trio of veterans consisting of Steinitz, Blackburne, and Tchigorin—the rear being brought up by Messrs. Mason, Tinsley, Bird, Lee, and Teichmann, the latter of whom has been compelled to retire owing to ill-health. Much may yet happen to change the present order, but it seems fairly certain that Janowski, Lasker, Maroczy and Pillsbury, will all be in the first six, and that the first three prizes will fall to three of these four. Steinitz will no doubt improve as he gets into better practice, but some of the Englishmen are evidently out-classed, and it is difficult to see why they were selected in preference to Herren Marco and Mieses, who, possibly from choice, are playing in the minor tournament.

Mr. F. J. Marshall, the new American master, who played at Board No. 8 in the recent cable match, at present holds the lead in the minor tourney. The other competitors are Messrs. E. M. Jackson, E. O. Jones, O. C. Muller, H. Erskine, T. Physick, and Dr. Smith, all of England; the foreign element being represented by G. Marco, J. Mieses, M. Tabountschikoff, J. Esser, and J. O. Klimsch. In this competition the English players are holding their own very well.

Result of the Minor Tourney:—1st, F. J. Marshall; 2nd and 3rd (equal), G. Marco and T. Physick; 4th and 5th (equal), E. O. Jones and J. Mieses.

KNOWLEDGE, PUBLISHED MONTHLY.

Contents of No. 163 (May).

Mother-of-Pearl and its Sources. By R. Lydekker. (*Illustrated.*)
Electricity as an Exact Science.—III. Arbitrary Assumptions and Expressions. Scientific Speculation as opposed to Hysteria. By Howard B. Little.
The Acetylene Industry.—II. By George T. Holloway, ASSOC. R.COLL. SC., F.I.C.
Clouds. By James Quick. (*Illustrated and Plate.*)
A New Star in Sagittarius. By Edward C. Pickering.
An Anglo-Saxon "Story of the Heavens." By E. Walter Maunder, F.R.A.S.
Letters.
Science Notes.
Notices of Books.
What is a Geological Catastrophe? By N. A. Graydon.
The Mycetozoa, and some Questions which they Suggest.—III. By the Right Hon. Sir Edward Fry, D.C.L., LL.D., F.R.S., and Agnes Fry.
Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.
Microscopy. By John H. Cooke, F.L.S., F.G.S.
The Face of the Sky for May. By A. Fowler, F.R.A.S.
Chess Column. By C. D. Locock, B.A.
PLATE.—Classification of Clouds.

Contents of No. 164 (June).

The Hereford Earthquake of 1896. By Charles Davison, SC.D., F.G.S. (*Diagram.*)
The Discoloration of Cut Apples. By G. Clarke Nuttall, B.SC.
On the Treatment and Utilization of Anthropological Data.—III. Racial Proportions. By Arthur Thomson, M.A., M.B. (*Diagram.*)
Secrets of the Earth's Crust.—III. The Makers of Flint. By Grenville A. J. Cole, M.R.I.A., F.G.S. (*Illustrated.*)
A New Satellite of Saturn. By Edward C. Pickering.
Nebulous Region round the Cluster N. G. C. No. 2239 Monocerotis. By Isaac Roberts, D.SC., F.R.S. (*Plate.*)
Letter.
Science Notes.
British Ornithological Notes. Conducted by H. F. Witherby, F.Z.S.
Notices of Books.
Obituary.
Wireless Telegraphy.
The Karkinokosm, or World of Crustacea.—IX. La Dignité du Chez-soi. By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S. (*Illustrated.*)
Microscopy. By John H. Cooke, F.L.S., F.G.S. (*Illustrated.*)
Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.
The Face of the Sky for June. By A. Fowler, F.R.A.S. (*Illustrated.*)
Chess Column. By C. D. Locock, B.A.
PLATE.—Photograph of the Nebula N. G. C. 2237-9 Monocerotis.

The yearly bound volumes of KNOWLEDGE, cloth gilt, 8s. 6d., post free.
Binding Cases, 1s. 6d. each; post free, 1s. 9d.
Subscribers' numbers bound (including case and Index), 2s. 6d. each volume.
Index of Articles and Illustrations for 1891, 1892, 1894, 1895, 1896, 1897, and 1898 can be supplied for 3d. each.
All remittances should be made payable to the Publisher of "KNOWLEDGE."

"Knowledge" Annual Subscription, throughout the world, 7s. 6d., post free.

Communications for the Editors and Books for Review should be addressed Editors, "KNOWLEDGE," 326, High Holborn, London, W.C.